

Climate Change

&

Naval War

- A Scientific Assessment –

Arnd Bernaerts

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A. Introduction

Scope and Aim

The presentation seeks to demonstrate that the industrialized world contributed to at least two significant climatic changes during the 20th century. Large-scale anthropogenic weather modification and climatic changes resulted from two destructive sea wars. This became particularly obvious when an arctic winter befell Northern Europe only four months after World War II had started. To establish a definite connection between war at sea and climate change, climatic data for first few months of WWII are analyzed in fourteen chapters. Climatic data are analyzed in respect of two war winters of 1940-41 and 1941-42, in six supplementary papers. It can be seen that record cold winters occurred in Europe only.

This elaboration is to establish further that two major climatic changes during the last century, viz. two decades of warming before WWII and four decades of cooling from 1940-80, are also closely linked to war at sea. WWI presumably initiated the warming process; and WWII definitely transformed the world into a cooler state. A total of nine chapters cover various findings in this respect.

On a preliminary overview, following topics, viz. North Sea cooling (2_16), Three-year-package (3_31); Ocean system affected (4_12); Spitsbergen heats up (5_12); and Climate changes (6_11, provide a basic picture of scope, method and contents of this research.

The book contains the written material on www.seaclimate.de. Only few changes have been made. Numbers formatted as follows, e.g. 2_16; 5_12, correspond with numbering of material on web site.

The main aim of this research is to support interest in oceanic affairs and awareness that oceans are the principal source of world climate. Such awareness together with a commitment towards protection of the oceans is necessary to prevent anthropogenic climatic changes in the future.

Contents of all papers presented are briefly dealt with in the following five sections.

B. Cooling of Europe

Europe gets arctic suddenly

WWII started during a period of fine weather. Previous months of 1939 had been entirely normal. Two decades of global warming had made the late 1930s the warmest time since the 16th century. Only four months later Northern Europe became like arctic in the winter of 1939-40. That did not happen 'out of the blue.' Since September, the North Sea had blocked Atlantic cyclones from moving east on common ways via Central Europe. The reason is obvious. Enormous naval activities in the area had stirred and churned large seawater areas.

Cyclones and shells

While war in the North Sea and Baltic Sea are definitely the primary source of arctic winter weather in Europe, war at sea in the Atlantic might have contributed to or modified weather conditions in late 1939. Barrage, bomb explosions and cyclones certainly remain factors to be reckoned with, when naval warfare is waged.

Europe wet - USA dry

In addition to the impact which war in the North and Baltic Sea had in converting Northern Europe into an arctic winter, a few further events during the late months of 1939 contributed to give Europe the ice age winter of 1939/40. A key point in this respect is the question as to why the whole Northern Hemisphere had fallen victim to polar air in January 1940. Anthropogenic factors appear to have played a key role. Three chapters analyze this phenomenon: Military activities in Western Europe caused it to rain 'cats and dogs', the United States received record low rainfall from October to December to which the War in China in 1939 could have contributed its mite. The USA dried out.

War by minus 40° Celsius

The war between the Soviet Union and Finland in December 1939 could have deprived regions in Russia and Asia of their 'usual' precipitation. The weather under the Arctic Circle went through extremes, which is outlined together with war activities to illustrate that the events up in the far north made it difficult to consider them as 'natural variations'.

Southern Europe events

What was definitely natural, with a brief regional weather impact, was a major earthquake in Anatolia on December 27, 1939. The quake occurred without leaving any significant trace on the arctic winter in North Europe. That came from blocking the common path the cyclones used to move along. The Atlantic depressions had to take another route, either to the north, e.g. turning up in Finland, or they went to the Mediterranean Sea.

C. Three European winters: 1939-42

The war winter of 1940-41

All three war winters of 1939-42 were arctic cold from Stockholm to London, and particularly in South Norway and Oslo regions. Only few months after the German Reich had attacked and invaded Norway in 1940, Southern Norway, the Skagerrak and Kattegat region fell prey to arctic conditions. That demonstrates the impact the of war at sea on regional winter weather conditions.

The war winter of 1941-42

As the previous war winters could be related to WWII, the third war winter is another massive demonstration that naval warfare between the Russian Baltic Fleet and the Kriegsmarine in 1941 not only resulted in extreme Baltic Sea Icing but also drove Sweden to extreme cold levels which would have been called extreme even during the Little Ice Age, effecting all Western Europe from the Baltic to London.

Arctic winter package

Considering that successive cold winters are an exception, the three war winters, occurring consecutively as a three-year-package with conditions never observed before, convincingly demonstrate man-made impact on winter weather conditions during the war years 1939-42.

D. Sea war and climate changes

Global sea war effect

Four decades of global cooling still need to be explained as the warming that started at the end of WWI, but came to an abrupt end with the winter of 1939/40. After the war at sea in Europe came global war at sea from 1942 to 1945 which took place in almost all parts of the North Pacific and Atlantic

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and churned huge seawater masses. All these events most likely affected the course of climate over four decades and possibly even longer.

Winter of peace 1946-47

18 months after WWII had ended a late cold winter occurred and is still remembered, which like the icy winter of 1928/29 raises the question: where did they come from?

E. Severe Warming 1918

WWI warms Arctic

Climatic change at Spitsbergen in 1918 due to a sudden extraordinary temperature rise started all around the British Isles that saw tremendous naval activities off all its coasts. Initially the war at sea brought cold and snow rich winters to Britain. Subsequently the war at sea activities may have initiated and even caused the severe Warming at Spitsbergen in 1918, followed by the acknowledged “Greening of Greenland” for one decade and the “Warming of Europe” until the start of WW II, which ended the milder climate within four months in 1939.

F. Climate changes twice

How the two world wars can fit into the greater context of global temperature rise since about 1880 and what is to be inferred from available data that two short wars at sea caused serious and significant winter weather and global climatic conditions for decades is elaborated.

G. References

Footnotes have been kept very short. Names refer to a List of References with full details. An immediate access to referred authors and articles is available on www.seaclimate.com ; www.seaclimate.de . Some earlier papers of the book author are accessible via www.oceanclimate.de.

About the Author

As trained seaman and master mariner the author was shipmaster before he became lawyer and doctor of law in the 1970s, with a law office in Hamburg, and international consultant since the 1980s.

In 1988 FAIRPLAY PUBLICATIONS Ltd, Coulsdon, Surrey, England, published his book "Bemaerts' Guide to the Law of the Sea - The 1982

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United Nations Convention". The Guide of 1988 edition is available via www.bernaerts-sealaw.com, and as hardcopy as a reprint of the 1988 Edition, by Trafford Publishing Canada, 2006, ISBN 141207665-X.

Prologue

Article from 1993

The following text is an article by the book author published 1993 in '*L.O.S. Lieder*' of the Law of the Sea Institute, William S. Richardson School of Law; University of Hawai.¹

WARMING UP -- SCIENCE OR CLIMATE

The climatic change issue has recently become one of the most serious challenges facing humankind. As *L.O.S. Lieder* insists on brevity, even though this issue deserves to be discussed at length, I beg your forgiveness for formulating my thesis directly and perhaps somewhat dramatically: climatic specialists and those people who have contributed to recent debates are possibly as much of a threat to the climate as the pollution caused by industrialization. For almost one hundred years, science has failed to realize that climate and the oceans are one and the same thing. As a result, the 1982 U.N. Convention on the Law of the Sea, the only true treaty dealing with climatic change issues, was thwarted the moment it came into effect over ten years ago.

Although climate should long ago have been defined as "the continuation of the ocean by other means," the Framework Convention on Climate Change of June 1992 came up with an alternate definition: "The totality of the atmosphere, hydrosphere, biosphere and geosphere and their interactions." What this all boils down to is that climate is nature working in all its forms – a nonsensical definition and useless as a basis for legal regulations.

As recently as 1990, the Intergovernmental Panel on Climate Change (IPCC) came to the conclusion that CO₂ was altering the climate and that "understanding and detecting the earth's climate system must surely be the greatest scientific challenge yet to be faced by humankind. It is a worthy banner under which the nations of the world can unite" (IPCC, Working Group I, p. 328). Certainly not a bad thing for science. The 1992 Earth Summit resulted in an unprecedented success for the scientists working in the climatic area, forcing politicians to listen to them and paving the way for greater financial backing in an effort to understand and come to terms with the climate system.

1. Arnd Bernaerts, "Warming up --- Science or climate", *L.O.S. Lieder* it 28, Vol 5, January 1993, Professional correspondence from the Law of the Sea Institute, William S. Richardson School of Law, University of Hawaii.

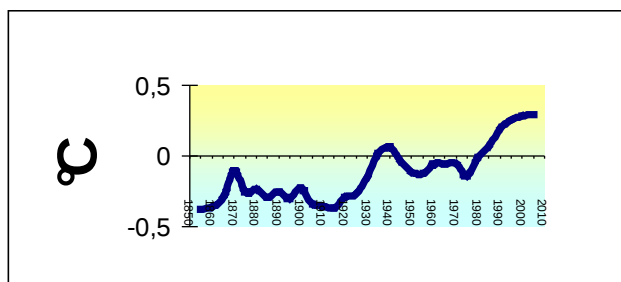
Yet, what is good for scientists is not necessarily good for the climate. The simple fact of the matter is that meteorology has never been particularly interested in climate except for statistical purposes, defining it as the average weather over a given period of time. On the other hand, there are the mathematicians, physicists and chemists, who do little more than apply their laboratory findings, theoretical conclusions and abstract calculations performed on greenhouse gases to a real natural system with little regard for the true essence of climate.

But while the seas continue to influence the climate, science is staring into the air (or, to be more precise, the atmosphere) in an attempt to find out what makes the climate tick. What is more, scientists have misled the international community of nations by claiming that greenhouse gases are the actual cause of climate change. This may yet prove to be the real tragedy of the climate change issue. After all, the oceans are still the part of the world about which the least is known. There is neither an "inventory" of the oceans nor an observation system. What is even sadder is that climate is still far from being acknowledged as the blue print of the oceans.

So beware of IPCC's call for unification in its attempt to come to terms with the climate. The climatic change issue is far too serious a matter to leave to those who should have known better for many decades and who were not interested in or aware of matters relating to the oceans. It is high time to enforce what is by far the best convention for understanding and protecting the climate — the 1982 U.N. Convention on the Law of the Sea — before it is too late. After all, it is the first global constitution and would therefore compel humankind to ensure that the planet remains a place worth living in. There is no need to "detect the earth's climate" and even less is there a need for a banner to serve IPCC's "greatest scientific challenge."

- / - -

General Trend in degree Celsius,



Northern Hemisphere Temperature Change 1850 –2000

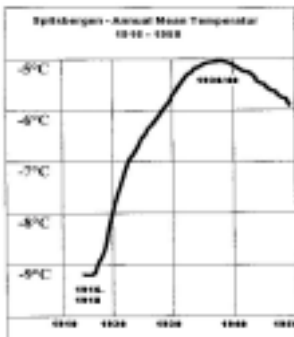
1. 'Big' warming starts (1918) – End of WWI, lasting until December 1939.
2. Warming stopped due to WWII (1939/40); Global cooling (1940-1980).
3. 'Warming trend from 1918-1939, interrupted 1939, resumes in late 1970s'

B. Cooling of Europe

Arctic Europe - winter of 1939/40 (2_11)

Climate Surprise

In autumn 1939 just 19 years had passed since WWI, named the Great War, had ended. With the end of WWI a dramatic temperature rise had started in the Northern North Atlantic, generating the expression “Greening of Greenland” and “Warming of Europe”. The ‘Big Warming’ was most pronounced at the Norwegian Island Spitsbergen (Svalbard) high in the North bordering the Arctic Sea. The pre World War II winters were the warmest for several hundred years. Suddenly, without any geophysical event, e.g. volcano, earthquake, or meteorite the Northern hemisphere in general, but particularly Northern Europe plunged to Ice Age conditions. Not nature had caused weather to change the course but huge naval armadas going into action on September 1st 1939.



Top Secret - The Weather

Censorship commenced with the start of WWII. Weather was given a top-secret place. Only when Britain plunged into glacial conditions, not experienced for many decades, His Majesty's Censor relaxed censorship on weather reporting and The New York Times was able to report as follows (excerpts):

“London, 27 January 1940
 British Cold Snap Can Now Be Told.
 Military Censorship on the Weather Lifted –
 Freeze Severest Since 1894.
 7-Degrees Low in London.
 Press Has Noted Subzero Spell in Europe
 Without a word of Arctic Conditions locally.



Now it can be told. For the first time since the war began, British censors today allowed that humdrum conversational topic, the weather, which has been a strict military secret in Britain, to be mentioned in news dispatches –

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providing the weather news is more than fifteen days old. The weather has been so unusually Arctic that by reaction the censors' hearts were thawed enough to permit disclosure of the fact that this region shivered since past several weeks in the coldest spell since 1894, with the mercury dropping almost to zero and a damp knife-edged wind piercing the marrow. While British newspaper readers' teeth chattered, the newspapers told them about a cold wave sweeping Europe, with sub-zero temperature records in Germany, Finland and neutral countries." (NYT, 28 January 1940).

Note: Temperatures reported by NYT are in Fahrenheit.

Introduction

WWII started during a period of fine weather. The previous months of 1939 had been entirely normal. Two decades of global warming had made the late 1930s the warmest period since the 16th century. Only four months later Northern Europe became arctic. Since September 1939 the North Sea had blocked Atlantic cyclones from moving east on common routes via Central Europe. (A) The reason is obvious. Enormous naval activities stirred and churned huge seawater areas, due to naval activities (B), which inevitably led to the North Sea and Baltic Sea cooling. (C)



Further details:

(A) Lost West Drift, 2_12.
(B) Sea war events, 2_13,
Sea mines, 2_14, Depth
charges, 2_15. (C) North Sea
cooling, 2_16; Baltic Sea
cooling, 2_17.

This section proposes to concentrate entirely on the ultimate outcome of the weather conditions in Northern Europe during the first

war winter of 1939/40. It will be done mainly by providing a list of significant events from mid December 1939 until the end of February 1940. These events will demonstrate in the most convincing manner how extraordinary and how severe this winter was. It shall particularly raise the awareness that the arctic winter 1939/40 must have been caused by something. Much of this information has been mainly compiled from reports from three newspapers: The New York Times (NYT), the Neue Zürcher Zeitung (NZZ) and the Hamburger Anzeiger. The marvellous job The New York Times did is highly appreciated. Their reporting was outstanding, excellent, comprehensive, detailed and prompt.

The list will also contain some general information or analysis of events of particular significance pertaining to the theme “war and weather”. On the other hand the list does not aim in any way to provide a detailed or complete account of the situation, but shall only describe, by a collection of certain examples, the severity of this winter. One cannot seriously discuss “climatic changes” as long as the reasons for the icy winter 1939/40 have not been discussed and explained. Nothing had happened on earth prior to 1 September 1939, respectively January 1940, that could have caused or been linked to the sudden arrival of this extraordinary cold winter, except that the Second World War had started. (A)

Further details: (A) concerning impact of El Niño, see : Lost West Drift, 2_12.

Before starting with the historical list of events, a brief climatic assessment on the severity of the winter conditions in Northern Europe is compiled. It was the coldest winter for more than 100 years for some countries or parts thereof, e.g. Sweden, Germany and Holland. The centre of the “cold pole” in winter the 1939/40 could be located within the triangle Rotterdam – Hamburg – Koenigsberg/Kaliningrad - Riga – Budapest¹. However, for all countries in the Northern European realm relevant information is compiled in the Chronicle (below, last section), just to give a basic idea as to the exceptional nature of this winter.

This work aims to prove that the war at sea caused this weather anomaly. Naval aspects during the initial war period of a couple of months are given in the three papers. (A) These analyses are also part of the wider investigation to prove that the five years’ war at sea during WWII caused the biggest man-made global climatic disaster in the last century, starting with the first war winter of 1939/40 and lasting for four decades. (B)

Further details: (A) Sea war events, 2_13, Sea mines, 2_14, Depth charges, 2_15. (B) Oceans at war, 4_11, Ocean system affected, 4_12.

Severity of the winter of 1939/40

Great Britain

Britain’s overall assessment:

- January 1940 had the lowest mean temperature over Britain. The mean temperature at sea level was 33°0°F over Scotland, and 31°7°F over England and Wales^{2,3}.

¹ Scherhag, 1951

² Lewis

³ Glasspoole

⁴ Gunton, H.C., (1939/40)

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- January 1940 was probably the coldest for 100 years⁴.

Some locations:

- Richmond (Kew Observatory)/London: January 1940 was the coldest since 1791⁵;
- Richmond (Kew Observatory)/London: January 1940 had the highest percentage of ‘frost days’ (87%) since 1854, and registered 84% morning frost⁶; of the whole winter (December-February) 58% were ‘frost days’ and 13% were ‘ice days’⁷;
- Greenwich: As regards mean temperatures at Greenwich in January the figure was the lowest recorded during the past one hundred years, it being 30.8° F, which is 7.8° F below normal and 0.9° F lower than the mean for the long – remembered January 1881⁸;
- in Kilmarnock (ca. 35 km south of Glasgow): on January 22, 1940 the temperature deviated by minus 25.3° F from average, the highest since 1902⁹;
- in Durham: January mean temperature (34.8°F) was the lowest of a table 1901-1940; the February temperatures correspondingly were the lowest since 1902¹⁰.

The Netherlands

The winter of 1939/40 ranks as No 8 in the list of the coldest winters since 1706, and was the coldest since 1845¹¹.

The record winter conditions were reckoned immediately:

- The meteorologists say that last month has been colder than any January in the last one hundred years, with mean daytime temperatures of 23 degrees Fahrenheit (-5°C). (NYT, 1 February 1940).
- “February has not yet reached January’s disagreeable record but during the last two days has not been far away”. (NYT, 15 February 1940).
- “The coldest winter since 1830.” (NYT, 20 February 1940).

⁵ Drummond, Table I

⁸ Dines

¹¹ Labrijn

⁶ Drummond, Table VII

⁹ Dunbar

⁷ Drummond, P. 30

¹⁰ Manley

Norway

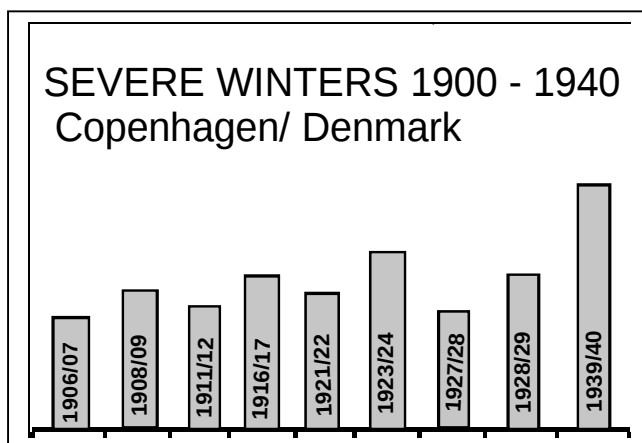
The mercury dropped to 54 degrees below zero Fahrenheit at Tynset, in Eastern Norway. (NYT, 18 January 1940).

Sweden

On the basis data for four months i.e., December – March, the winter of 1939/40 ranked 9th in the list of the coldest winters since 1757, trailing behind only the winters of 1880/81 (rank 6); 1837/38 (rank 5); 1808/09 (rank 2). On the basis data for three months the winter is ranked No.10., succeeding the winter of 1892/93 (rank 9)¹².

“In Sweden all cold records were broken in the last twenty-four hours, the coldest since 1805.” (NYT, 21 February 1940).

Denmark



Based on a list taken from ten observation stations from 1906 to 1941 the amount of cold in winter of 1939/40 was by far the severest at any of the places observed. The figures available, with the mean data

in respect of the 10 coldest years since 1906 in brackets, are as follows: Kobenhavn –378.5 (204.0); Fanø – 349.9 (208.2); Hammershus - 305.6 (176.4); Bogø – 438.0 (235.0). The lowest winter temperatures noted had been for December(-22.2°C); January(-24.3°C); February (-27.4°C); March (-22,0 °C)¹³.

“It is Denmark’s worst winter since 1860”. (NYT, 15 February 1940). The Chronicle (below) provides further information on the severity of the situation in Denmark.

¹² Liljequist, ,1757 –1942’

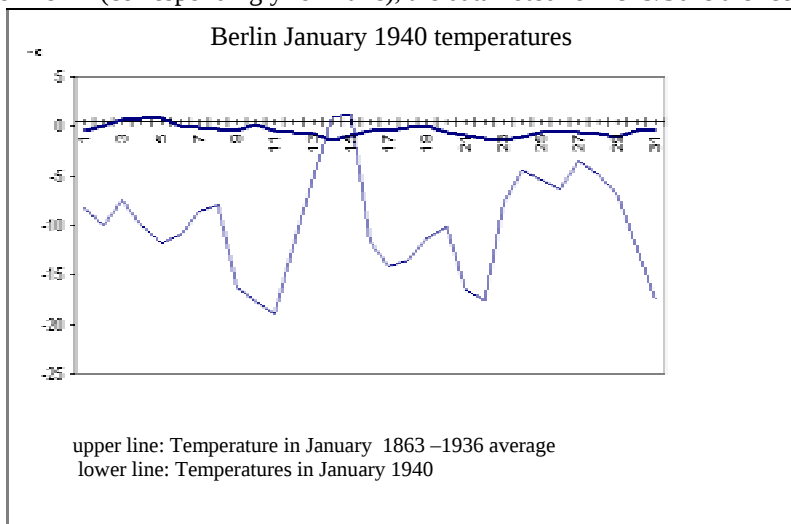
Baltic Countries

The lowest temperature in seventy years was reported at Riga, Latvia, with a reading of 47.2°F degrees below zero (-44°C); (NYT, 18 January 1940).

Remark: Information on the weather situation during the WWII war winters in the Baltic countries is rare, if existed at all. Presumably, Tallin, Riga and Vilnius experienced the same glacial war winters as Stockholm, Copenhagen, Rotterdam, and London from 1939 to 1942.

Germany

For Berlin and Halle it was the coldest winter in 110 years. The assessment is based on the ‘summary of the daily mean data from November to March’. For Berlin (correspondingly for Halle), the data noted for 1829/30 is the ‘cold



sum’ figure -791°C, for the winter 1939/40 the figure is -736°C¹⁴. These data are confirmed by other researches as well¹⁵.

The coldest January months with respect to Berlin since recording started in 1719 are: 1823, 1838 and 1940. With regard to the winter of 1928/29, February (-10.4°C) was colder than February 1940 (-7°C), but as January 1929 is not among the 20 coldest winter months, the winter 1939/40 ranks higher on the list of cold winters¹⁶For Dresden the winter of 1939/40 (December-February) was the second coldest in the 115 year record, only surpassed by the winter of 1829/30¹⁷.

¹³ Det Danske, 1939-40.

¹⁴ Lenke, P.92/42

¹⁵ Stellmacher/Tiesel

Dresden recorded the coldest January ever measured since observations started, with minus 9.1°C from average, while the previously lowest figure for 1838 was minus 8.2°C. It was the coldest January for at least 112 years¹⁸.

For Darmstadt (near Frankfurt a. M.) the winter was the severest since 1837/38 and 1829/30 accompanied with abundant snowfall¹⁹.

Hungary

The winter 1939/40 ranked 6th among the 115 year record, and occupied third place in the list of frost days, after 1829/30 (84), 1890/91 (82), and 1939/40 (76); while the coldest February in the last 115 years occurred during the winters of 1929/30 and 1939/40²⁰.

Switzerland

As observed by Groissmayr in 1947: "In contrast to Germany, Austria and Hungary, the winter of 1939/40 in Switzerland was short, the February was close to normal"²¹ while by comparison the difference in mean temperatures was -8.2°C in Königsberg, and -6° to -8°C in Hungary (compared with Switzerland's average temp.)²²

Italy

Italy experienced some cold from the end of December 1939 to mid January 1940.

A record low had been measured in Modena with 13.8°F (-25 °C) on 15th February 1940.
(NYT, 16 February 1940).

For further details concerning the weather conditions in the Mediterranean from end of December 1939 to mid January 1940 (see: Turkey quake, 2_51).

Turkey

(Black Sea - Rumania, Bulgaria)

An assessment concerning the earthquake in Turkey on 27th December 1939 is given in: Turkey quake (A). Further details: (A) Turkey quake, 2_51.

¹⁶ Fischer, ‚Berlin’

¹⁹ Fischer, ‚Darmstadt’

²² Groissmayr, 1947

¹⁷ Groissmayr, 1944, P 53

²⁰ NN, ‚Hungary’

¹⁸ Naegler, ‚Dresden’

²¹ Groissmayr, 1947

United States

The months October to December 1939 had been very dry all over the US, (A) which may have some connection to the military activities in Europe and Asia in autumn 1939.(B) January 1940 was cold, followed by a mild February²³ Due to above normal average temperatures over the arctic (and Siberia), the cold pole over Canada has moved south towards the US in January 1940. According to Scherhag²⁴ January 1940 saw the ‘typical picture of a weakened sectional circulation’. Brooks observed that most of eastern Canada north of latitude 48°N was above normal in January 1940, with deviations running up to more than 25°F above normal north of latitude 58° N and 18°F above normal in the interior of Alaska. Missouri was actually as cold as the Hudson Bay region for the month²⁵.

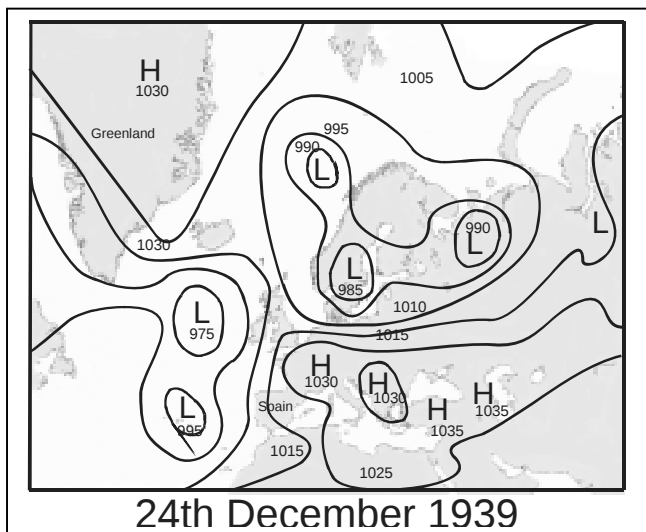
Further details: (A) USA dried out, 2_32; (B) Rain-Making, 2_31

Chronicle

Mid December 1939 to February 1940

NOTE: The temperatures reported by The New York Times are always in Fahrenheit; some of which have been converted to Celsius (in brackets).

22/23
December
1939;
Snowstorm at
the Petsamo
(Arctic) Front
in Finland with minus 30°C to minus 36°C (Frankfurter Zeitung, 23 Dec.39).



22 December 1939; A very severe snowstorm brought shipping in the Black Sea and the lower Danube river to a standstill on Thursday (21 December 1939). At the coast the temperatures dropped to 15°C below zero.

²³ Groissmayr, 1944

²⁴ Scherhag, 1951

²⁵ Brooks, 1939/40

The storm caused considerable damage in Bucharest. (Hamburger Anzeiger, 23/24 December 1939). Snow also fell all over Bulgaria on 21-22 December, starting a new cold weather episode (down to -16°C), 24th in Northern Bulgaria -20°C, (according to Bulgarian newspaper 'Zora'; by personal communication).

23 December 1939; Heavy snowstorm reported from Latvia (Hamburger Anzeiger).

24-27 December 1939: Baltic countries temperatures: In the Eastern parts of the Baltic countries (Russian West border) the temperatures fell to minus 17°C from the 24th to 25th, and below 20°C one day later, extending to the Baltic coast, with minus 14°C in Klaipeda and minus 17°C in Gdynia (Bight) on 27th December²⁶. (Newspaper reports)

28 December 1939; Snow storms sweep Denmark (Frankfurter Zeitung, 29 December 1939).

29 December 1939; Ice closes Danube to German supplies; Rail traffic expected to be hampered by snow (NYT, 30 December 1939); "Cold winds recently have been blowing westward from Russia and the constantly low temperature in the river valley indicates a general freeze will set in soon." (NYT, ditto).

29 December 1939; From Agram in Yugoslavia temperature of minus 32°C is reported. (Neue Zürcher Zeitung, 31 December 1939).

30 December 1939; Cold wave over the Riviera. In Genoa a rapid fall of temperature was followed by an extensive snowstorm. Trieste reports heavy winter storms. Milan had minus ten degrees Celsius during the Saturday night. (Neue Zuercher Zeitung, 31 Dec. 1939).

30 December 1939; "An unprecedented and severe snow storm in Naples region today indirectly caused a train wreck in...". "Rome's heaviest snowfall in recorded history - six inches - made the Romans feel as New Yorkers did in the 1888 blizzard. There had been nothing close to this as snow fell for three days continuously from December 16 to 18, 1846. (NYT, 31 December 1939), (so also: Neue Zürcher Zeitung (2 Jan. 1940), but snow fall lasted only for eight hours. The snow melted away in a few hours on 1st January 1940).

30 December 1939; Roma covered by 25-30 cm snow; Venice minus 5°C; Finland's Arctic Front minus 48°C; record cold in Sweden and Norway with

²⁶ Seewarte

minus 40°C (earlier severest in January 1914 minus 50°C); severe cold in
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Yugoslavia with minus 23°C (Frankfurter Zeitung).

31 December 1939; cold wave in Bulgaria, the lowest at Rustschuk at the Danube river with minus 20°C. Banja Luka/Westbosnia minus 27°C; in Slovenian cities minus 26°C. (information by personal communication)

31 Dec. 1940; The Atlantic island Madeira reports a violent storm on Sunday (31 December) with heavy flooding. (Neue Zürcher Zeitung, 2 January 1940);

31 December 1939; Thin ice reported at Biala, River Danube – 11°C²⁷

January 1940

1 January 1940; All navigation on Danube stopped owing to ice²⁸.

3 January 1940; Heavy snowstorms reported again from Denmark and traffic at Jutland is affected. (Neue Zürcher Zeitung, 03 Jan. 1940).

2 January 1940; Weather curtails West Front Action. (G.H. Archambault reporting) With the cold becoming keener and much snow under foot, activity on the Western Front is best described as relatively – very real to the men who must continue to patrol, but virtually insignificant from a military point of view. Rain and mud are bad enough; snow and ice are even worse. (NYT, 3 January 1940).

8 January 1940; A record frost today covered Northern and Central Russia, with the thermometer at 31 degrees below zero Fahrenheit (-35°C) and affected normal activity. (NYT, 9 January 1940). Sport events have been cancelled. Twelve persons with frozen legs – the majority intoxicated – were picked up by ambulances. (NYT, 11 January 1940).

10 January 1940; Cold weather, worst in Hungary since 1929, is expected to break all previous records. Already the Danube is a solid sheet of ice. (NYT, 11 January 1940).

11 January 1940; Rumania. Temperatures as low as 40 degrees below zero Fahrenheit (-40°C); Bulgaria was reported to be suffering under the worst cold in the memory of living persons, with scores of villages isolated by snow. (NYT, 12 January 1940)

²⁷ Frankcom

²⁸ Frankcom

11 January 1940; Sea freezing near Odessa. Very low temperatures over the Black Sea. Rumania caught in minus 33 °C cold, (according to Bulgarian newspaper 'Zora'; by personal communication).

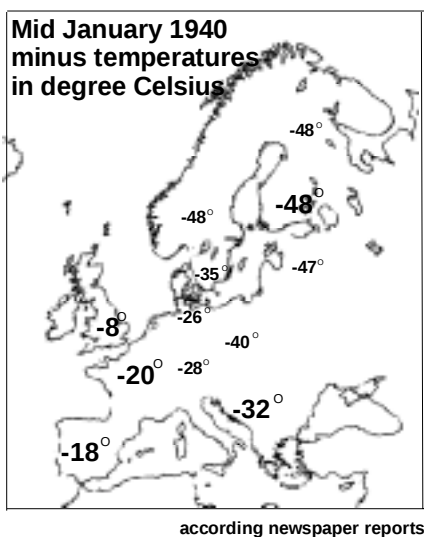
11 January 1940, Berlin: Mercury dropped to about four degrees below zero, Fahrenheit (-20°C), in the capital and to about five below zero in the suburbs. (NYT, 12 January 1940).

11 January 1940; Riga -41° C; Budapest -26° C (Neue Zürcher Zeitung, 11 January 1940).

11 January 1940; Budapest -26, Vienna -25, Sofia -22; heavy and icy storm over North Italy; shipping halted in The Netherlands by frozen rivers; icing between the Danish islands (Neue Zürcher Zeitung, 11 January 1940)

12 January 1940; Amsterdam. Floating ice is halting traffic on the rivers Rhine, Maas and Yssel. The ports of Amsterdam and Rotterdam are being kept open with considerable difficulty. The cold increases losses already caused by war conditions. For instance, the number of ships calling at Rotterdam has dropped from 1,300 per month before the war to 380 now. (NYT, 13 January 1940).

12 January 1940; From the lowland of Rumania a severe cold of minus 35° C flows to Besarabia. The ice in the Danube becomes more firm and has already reached a thickness of 35 cm at some places. (Neue Zürcher Zeitung, 13 January 1939).



13 January 1940; The temperatures fell to 25.6 degrees below zero Fahrenheit (-31.5°C) in Northern Rumania, and many villages in Dobruja were snowbound. (NYT, 14 January 1940).

13 January 1940; Riga/Latvia; The bitterest cold wave for years, which sent temperatures in the Baltic countries down to as low as 40 degrees below zero Fahrenheit, ended here abruptly today. The mercury rose rapidly to a few degrees below zero. Parts of the Baltic Sea have frozen over and floating and pack ice are likely to interfere with shipping for some time. (NYT, 14 January 1940).

13 January 1940; In the Soviet Union, extreme cold, particularly at the Don, temperatures on Friday, 12 January was minus 38° C. (Neue Zürcher Zeitung, 14 January 1940).

14 January 1940; Amsterdam. A break in freezing weather supplemented by rain, fog and melting ice (came). (NYT, 15 January 1940). At least two ships were crushed in ice packs on the Rhine and IJsselmeer Rivers and thirty others were damaged severely. (NYT, 14 January 1940).

15 January 1940; Temperatures of 40 degrees below zero Fahrenheit reported from Warsaw, and the Danube frozen solid, there is no doubt that Eastern Europe is in the grip of an icy winter which is made doubly hard by the war. (NYT, 15 January 1940).

16 January 1940; Headlines: Snowstorm eases anxiety in West. German Attack; Dependant on Machine; Held Unlikely in Present Weather. No Visibility for Planes. Snow has been falling steadily all day long after a night of heavy thaw. (NYT, 17 January 1940).

17 January 1940; Cold paralyses Northern Europe. The unexpected swiftness with which temperatures fell was featured in almost all weather reports. After comparatively warm weather over the weekend, the temperatures suddenly began dropping towards the bottom of the thermometers. A typical report from Riga said that the temperature was at freezing point on Monday morning (15 January) and at 22 degrees below zero Fahrenheit yesterday morning. Then it tumbled to 47.2 degrees below zero – a drop of 79.2 degrees in about thirty-six hours. (NYT, 18 January 1940).

17 January 1940; In Copenhagen: 14.8 degrees below zero Fahrenheit (-26°C) was registered early today; there was no sign that the cold wave would abate soon. Heavy snowstorms accompanied the cold, and traffic in many parts of Denmark was impeded or brought to a standstill. (NYT, 18 January 1940).

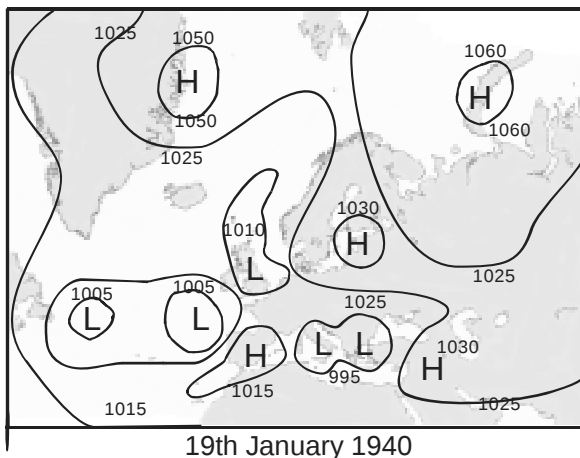
17 January 1940; Moscow. Severe cold continued in Moscow today, the average morning temperature being 49 degrees below zero Fahrenheit (-45°C). (NYT, 18 January 1940).

17 January 1940; Helsinki. "Pitiless, deathly cold laid a glacial hand on Russian's war machinery tonight... near Salla, above the Arctic Circle. Phenomenal 54-degrees-below-zero Fahrenheit temperature (-48°C) restrained the Russian air forces, ...and apparently immobilised Russian ground forces, which have been attacking on the Karelian Isthmus. (NYT, 18 January 1940, front page). At Viborg the thermometer registered 54.4 degrees below zero Fahrenheit, while at Helsinki the temperature sank to 23.8 below zero Fahrenheit. (NYT, 18 January 1940, inside page).

Remark: As both cities are less than 200 km apart the difference should be seen with suspicion.

Tallin, just opposite the Gulf of Finland reported 14.8 degrees below zero. On the other hand Riga reported 47.2 degrees. (ditto). In Berlin the temperature tumbled 40 degrees, but the exact reading could not be transmitted abroad 'because of military reason'. (ditto).

17 January 1940; Budapest. The Danube is entirely frozen over. About 1,200 tugs and barges fully loaded have taken refuge in Hungarian ports. About 85 per cent of the transport is destined for Germany. Of these, 200 are oil tankers and 400 carry grain. (NYT, 18 January 1940).



21 January 1940; "The cold polar air remained stagnant over vast areas of Europe and North America. Result: One of the coldest weather in half a century. In Moscow the temperature dropped on Wednesday (January 17) to 49 degrees below zero Fahrenheit (-45°C),

in parts of Finland to 58 below zero. Such temperatures can be measured only on alcohol thermometers, as mercury freezes solid at 38 below. (NYT, 21 January 1940; Weekend in Review, 'War in the Cold').

21 January 1940: -23C was recorded at Rhayader (Wales).

22 January 1940; Severe snowstorms swept Europe from the Adriatic Sea to Scandinavia. (NYT, 23 January 1940).

26 January 1940; Headline: Cold Greater Foe Than Germans For French Army in Front Lines. Most Severe Winter in Generations Taxes Troops' Endurance to the Limit but Test Is Met With Courage (NYT, 27 January 1940). It has been freezing for six weeks. Everything is frozen – the bread in the sling bag, the wine in the canteen. (ditto).

28 January 1940; In the close vicinity of London the river Thames has frozen for the first time since 1814. (Neue Zürcher Zeitung, 29 January 1940).

29 January 1940; Icy Storm Hits Britain; London Has Heavy Snow (NYT, 29 January 1940). Heavy snow paralyses Britain; Transportation is badly

affected. Trains from Scotland fail to reach London. The united Press said that snow was falling over most of the country yesterday and that the cold broke a forty-six-year record. Snow still was falling heavily over most of the country today and there were three inches of snow in the centre of London. (NYT, 30 January 1940).

31 January 1940; Crawford/Scotland had been cut off by a blizzard raging over the British Isles last Saturday (27 January). Newspapers permitted to publish the first details of the blizzard, called it the coldest weather in a century. (NYT, 01 February 1940).

February 1940

1 February 1940; Activities increase on Western Front. French send out four patrols as cold moderates. With the cold becoming less bitter on the Rhine-Moselle front, more activity is developing. ...Once again casemates along the Rhine have exchanged shots. After months of complete calm such exchanges are becoming more frequent. (NYT, 2 February 1940).

11 February 1940; Copenhagen. Temperature is still dropping today and is between 7 degrees above and 5 degrees below zero Fahrenheit in Denmark. Due to energy shortage the government ordered drastic restrictions forbidding the use of hot water, geysers and kitchen pipes until 1 April, getting the whole of Denmark splashing in bathtubs to get its last hot water bath for some time to come. (NYT, 12 February 1940).). Similar shortages had been reported in Germany three weeks earlier: Nazis Tighten Water Ban. Berlin Heating Plants to Issue it Only Twice Weekly. (NYT, 20 January 1940).

11 February 1940; Sweden. Stockholm set a lowest record with 13 degrees below zero Fahrenheit (-25°C). (NYT, 12 February 1940).

13 February 1940; Europe suffered tonight ...in the cold wave, which extended from the Arctic fringes of Norway and Finland...the Baltic countries, to the Netherlands and Hungary. (NYT, 14 February 1940).

13 February 1940; Amsterdam. Europe suffered tonight in the paralysing grip of the bitterest cold in more than 100 years. Hundreds of persons abandoned their homes in the face of crushing ice packs boiling up from ice-locked canals, rivers and seas.

Weather Bureaus here recorded the lowest temperature ever recorded in this country, 11.2 degrees below zero Fahrenheit (-24°C). To the Netherlands, which has a rather mild climate, this is more severe than the lowest temperatures recorded in Minnesota. The average for the whole country was 1.4 degrees above zero (-17°C). Water transportation in the Netherlands has been completely paralysed. The canals have been covered with thick ice for

more than six weeks, while the traffic on the Rhine and Waal stopped on January 11. (NYT, 14 February 1940).

13 February 1940; Copenhagen. The temperature has dropped to 13 degrees below zero Fahrenheit (-25°C). (NYT, 14 February 1940).

13 February 1940; Baltic countries. In Estonia, Latvia and Lithuania more than 10,000 persons suffered severe frostbite. At least five persons froze to death in the three Baltic countries, where temperatures reached 54 degrees below zero Fahrenheit ($-47,7^{\circ}\text{C}$) recently for the first time in 160 years (NYT, 14 Feb. 1940). Baltic Sea frozen over. (ditto).

13 February 1940; Hungary. The most severe snowstorm in memory has been raging over Hungary all evening. The whole country is covered with snow several feet deep. (NYT, 14 February 1940).

13 February 1940; Romania. Romania reported heavy snowfall particularly in Bessarabia. (NYT, 14 February 1940).

15 February 1940; All records for cold in Europe were broken last month and just when it was hoped the worst was over, another cold wave has bound the whole continent. (NYT, 15 February 1940).

15 February 1940; Budapest suffered today from the bitterest cold for sixty years, 28 degrees below zero Fahrenheit (-33°C). (NYT, 16 February 1940).

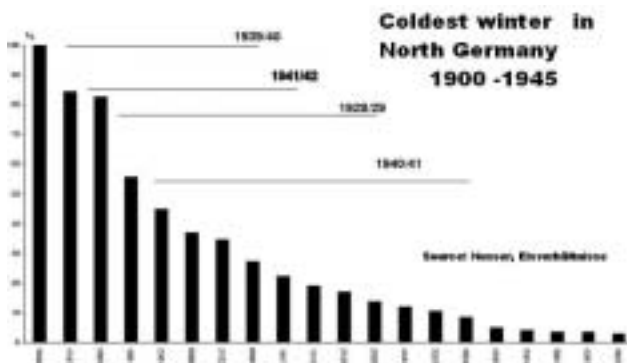
15 February 1940; Ice-locked canals and rivers and snowbound trains made it impossible to transport coal. New blizzards, with snowfall heavier than any in Germany for decades, caused delays for hours in all transportation. Snow was three feet deep in the streets of Berlin's suburbs. 15 February 1940; Italy is undergoing a new period of exceptionally severe cold with temperatures several degrees below freezing in some northern towns. The record low today was held by Modena with 13.8 degrees below zero Fahrenheit.



15 February 1940; In France canals that had been icy for weeks had scarcely been opened when the new cold wave bound the broken ice blocks again, immobilizing barges everywhere. (NYT, 15 February 1940).

17 February 1940; Slovakia. Cold cripples Slovakia. Following two days of snowfall and a period of bitter cold, Bratislava was largely cut off from the outside world. (NYT, 18 February 1940).

19 February 1940; Holland/Amsterdam. The coldest winter since 1830. (NYT, 20 February 1940).



20 February 1940; In Sweden all cold records were beaten in the last twenty-four hours with 32 degrees below zero Fahrenheit (-35,5°C), the coldest since 1805. The

previous record in Stockholm was 22 degrees below zero F. Copenhagen tonight 2 degrees above zero Fahrenheit. (NYT, 21 February 1940):

22 February 1940; Berlin had a sudden thaw today after two months of cold and snow such as the city has not seen for decades. At Warsaw workers clear away nearly three feet deep snow. (NYT, 23 February 1940).

25 February 1940; Danube river is still ice-choked. (NYT, 26 February 1940).

Conclusion

The Chronicle is self-explanatory. The extreme conditions were not mere 'natural variations' but caused by the war at sea. (A)

Further details: (A) North Sea cooling, 2_16, Baltic Sea cooling, 2_17.

West Wind lost – Europe cut off (2_12)

Introduction

Weather from normal to arctic

Climatic conditions of the year 1939 were close to usual before WWII started on September 1st. On the basis of previous annual statistics nothing abnormal was expected. No one suspected that anything concerning weather could go wrong with the first war winter. It is an acknowledged fact that temperatures had been rising steadily in Europe since the end of World War I. Winters previous to 1939 were all normal. The winter of 1938/39 had been mild except for a brief cold spell in December 1938 that lasted from 15 to 20 December only and was fully replaced by warm Southwest winds beginning January 6, 1939. However, if there was a contribution, it was presumably El Niño, which is given reasoning in the following paragraph. But no one expected or imagined a much different situation twelve months later. Only four months after Hitler had started WWII, the weather in Western Europe became 'violent' with floods, storms, snow and icy conditions. From the North Cape to the Mediterranean the weather statistics described North Germany, Holland, Southeast England, Denmark, Sweden, and presumably the Baltic countries as experiencing the coldest winter in more than 100 years. (A)

Further details: (A) Arctic Conditions, 2_11.

Cold December 1938 and was El Niño involved?

Bluethgen¹ gives a detailed assessment of the severe December 1938 cold spell. This cold air from the 'Petschora Basin (Pechorskaya Guba)' seems to have had other causes than the emerging arctic conditions in December 1939. But even if they did not, this could be used as a contributing piece of evidence. The December 1938 event was short. Actually, the winter of 1938/39 was mild. That a 'repetition' did not occur in December 1939 indicates that the underlying climatic conditions (North Sea and Baltic Sea) had changed within only three months of the start of war so much that the weather in Western and Northern Europe could not return to 'normal', viz previous winter conditions².

¹ Bluethgen

² Douglas

Why back to the ice age in winter 1939/40?

How could this happen? What caused the weather to play havoc? Why was Europe thrown so easily back into the ‘ice age’? This section presents the viewpoint that the war at sea was the main cause that changed the weather conditions in Europe. The main theses are:

Thesis I: During autumn and winter the warm water of the North- and Baltic Sea (in comparison to the coldness of the continental land masses due to lack of sunshine) attracts the ‘west wind drift’^{*)} on which cyclones travel eastwards across Western Europe, blocking continental high pressure systems with cold air from moving to West-Central Europe or at least keeping them at bay. The earlier and/or more the stored summer heat of these seas is diminished by force earlier in the winter, more forcefully continental anti-cyclones will take control, which may reach the Atlantic coast of the British Isles. Effective means of ‘squeezing’ heat out of the sea are wind, waves and all military and naval activities. (A)

Further details: (A) North Sea cooling, 2_16, and Baltic Sea cooling, 2_17.

^{*)} German meteorologists prior WWII used the term ‘west wind drift’, a term which is today commonly used for Antarctic circumpolar wind and current.

Thesis II: The flow of ‘normal’ weather processes in the atmosphere depends on the balance between humidity in the air and its concentration and transport by low-pressure systems, or vice versa, the dry air of high-pressure systems. This balance can be easily affected by reducing the amount and concentration of ‘water’ in the atmosphere. That this definitely occurred along and behind the Western Front of several hundreds km length from Dunkerque (France) and Emden (Germany) to Basel (Switzerland) is explained in section: Contributing matters. (A)

Further details: (A) Rain-Making, 2_31; USA dried out, 2_32, and War in China, 2_33.

Meteorological developments in autumn 1939 in focus

This chapter proposes to show that the meteorological developments since September 1939 indicate clearly that conditions of the North Sea helped pave the way for plunging North-Western Europe, from Southern England to the

Baltic Countries into the coldest year since early 19th century. Military activities changed the seawater temperature structure of Europe's northern seas, 'forced' humidity out of the atmosphere at the Western Front. This event did not disappear without leaving any traces. To prove this point the daily "weather analysis" reports of the Deutsche Seewarte, as part of the daily weather records, will be used to show that during the period from September to December 1939, there were indications that the weather in Middle Europe did not behave according to the 'rules of average'. The aim is to adduce evidence to prove that this winter in question did not emerge 'out of the blue' but developed gradually and due to anthropogenic making.

Start of Winter analyzed by Neue Zürcher Zeitung



According an analysis by the Neue Zürcher Zeitung (NZZ, 14 January 1940) the development of cold conditions happened as follows:

„Severe cold which flooded the whole of Europe in the course of this week was by no means an accidental phenomenon that set in surprisingly. It rather constitutes the peak of a development which had its beginning in the first week of December. Towards its end high pressure began to stabilize in North and Middle Europe, keeping away the low Atlantic cyclones from the continent and diverting them mainly through Greenland and Iceland waters to the Sea....As soon as occasional Atlantic depressions moved East through the North and Baltic Sea, they were immediately replaced by entry of cold air from the Greenland area.”

Little convincing is the assumption made shortly after WWII, that the “shift” to the severe winter conditions of 1939/40 was caused by a sudden build-up of a cyclone off the Lofoten on 20th December 1939³.

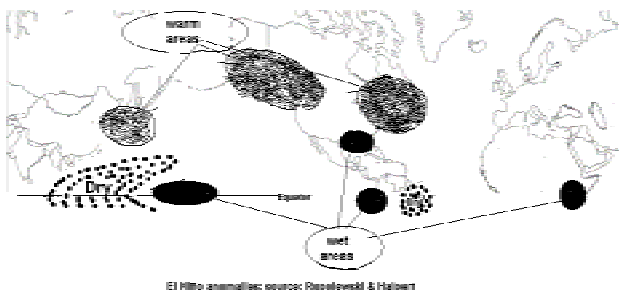
What role did El Niño play?

Although the scientific approach of this work is to elaborate historical data and views, an exception shall be made with regard to recently published articles concerning the long-distant effect of El Niño.

³ Rodewald, Golfstrom

⁴ Broennimann et. al.

Recently Stefan Broennimann and his colleagues inquired the causation of the extreme European winters 1940-42⁴. We fully support the conclusion “that the global climate anomaly in 1940 to 1942 constitutes a key period for understanding of large scale climate variability”, but have reservations in following Broennimann et. al. linking the arctic war winters decisively to El Niño. As this is not the place to reply in detail, only a brief comment shall be given.



It is a long established fact that El Niño events can be linked to unusual short-term weather deviations in distant regions, but Northern Europe is only

remotely affected. During the last 150 years the Pacific Ocean experienced about 40 El Niño events. Some severe winters coincide with events, some not (e.g. 1916/17, 1928/29). Nevertheless, modest influence cannot be denied outright. In July and August 1939 an El Niño event reached its height having caused the best vegetation in Peru for 14 years⁵, but the 1939 El Niño was not particularly anomalous⁶. In autumn 1939 the event had already reached the culminating point.

Frequently in 3 to 7 years interval, a warm water pool that causes the El Niño effect generates in the western Pacific north of Indonesia and moves along the Equator toward Central and South America. The moving time is about nine months⁷, while Dake Chen et. al.⁸ concluded recently that the motion of the pool is causing changes in the atmosphere and not vice versa. Thus the brief cold spell in Northern Europe in December 1938 (see above) could possibly have been caused by a warm water pool that started to leave the western Pacific in late 1938 to become El Niño 1939 a couple of months later.

After all, the warm water pool is relatively small, presumably of a volume corresponding to a few times of water masses held by the North Sea when traversing the Pacific starts, respectively an area comparable to that of Australia, to a depth of 50 to 100 metres⁹ at a later stage. The extra heat

⁵ Schwabe

⁸ Chen et. Al

⁶ Bigg & Inque

⁹ Lukas & Webster

⁷ Gross

stored is substantial but limited. The temperature may be up to 4°C higher than usual. Correspondingly the time duration for causing local and long distant effects is limited. The 1939 El Niño culminated in late summer 1939. Thereon El Niño receded, as the full cycle is 1 to 2 years. Even if the water pool still held any surplus heat it had little if anything to do with the record dryness in the USA during the fourth quarter of 1939 and the glacial cold spell all over the Northern Hemisphere in January 1940 and the arctic winter in Europe lasting until March 1940, which is elaborated in more than a dozen following chapters.

Further details: (A) USA dried out, 2_32.

There are even less reasons to assume that the equatorial Pacific had anything to do with the 2nd and 3rd glacial war winter in Europe either. For long many scientists claim that there had been a prolonged El Niño lasting from 1939 to 1942. This has never convincingly been established. The Pacific does not provide the “physical conditions” – as explained in the previous paragraph – for a prolonged eastward flow of warm water. As far as observations between 1940 and 1942 might have indicated to El Niños actual causation might be quite different. The claim of prolonged El Niño condition is largely based on Sea Surface Temperature (SST). Due to the war conditions these data are not reliable, neither for the Pacific¹⁰, nor for the North Atlantic¹¹. Furthermore should be considered that extreme weather conditions in Europe caused by cooling the North and Baltic due to naval warfare (2_16), (2_17) could also produce a long distant effect, e.g. in the Pacific region, which may look like as belonging to an El Niño. It is critical to regard the El Niño of 1939 as a prolonged event until 1942. If there was no such prolongation then the Broennimann’s theses on El Niño relevance for arctic war winters 1940-42 in Europe¹² would require further explanation, as well the fact that other severe winters occurred outside the event period (e.g. 1916/17, 1928/29). Further discussion in this paper shows that the making of the arctic winter 1939/40 came from regional conditions leaving little if any role for the Pacific to intervene in high Northern Hemisphere weather affairs.

Effective start of the winter of 1939/40 elaborated

Excellent weather analysis by the NZZ on 14th January 1940 came to the conclusion that the origin of the cold wave across Europe could be traced back to the first week of December 1939, even though the actual process had started much earlier. Though the NZZ assumed the change in weather conditions to have taken place since the 1st week of December 1939, a high

¹⁰ Bernaerts, Pacific

¹¹ Bernaerts, Atlantic

¹² Broennimann et. al.

¹³ Seewarte

pressure kept Atlantic cyclones away from North and Middle Europe latest since October 1939. To prove this theory this paper will depend to a large extent on daily weather reports of German meteorologists at the Seewarte in Hamburg during the first four war months, viz. September - December 1939¹³.

While discussing the cooling of Europe in late 1939, a brief assessment of the general conditions during the year 1939 will be presented in the form of weather analysis clippings by meteorological services in respect of North Europe compiled by the author. This is to show that the climatic conditions during the first eight months of 1939 until the end of August had been exceptionally normal without any significant deviation. This means that the Second World War started on a 'clean sheet' of normal climatic conditions.

Weather during 1939 – Four country assessment

The following four extracts should be read keeping in mind that WWII started in September 1939 and that climatic conditions were not necessarily 'normal' during the final four months of the year or first four months of the war, i.e. September to December 1939. Particularly the record rain area stretching from Dresden and Basel to London from September to November 1939 is already war related. (A)

Further details: (A) Rain-Making, 2_31.

The weather on the British Isles during 1939

While weather conditions were almost average, the spring again had a succession of warm spells interspersed with brief cold spells. After a warm and sunny start in early June, the summer was comparatively sunshine-free with an early autumn, with the exception of a warm period in August and early September. As in previous years, November was very warm. There were, however, very few gales. There was a notable above average rainfall in the South-eastern districts and below average in the North-western districts. Rains, far in excess, occurred in the Southeast. Actually, in October 1939 Southeast England recorded excess rainfall of more than three times the average and November recorded twice the average¹⁴.

The weather in Germany during 1939

German meteorological analysis for the months January - June 1939 notes a weather with a tendency to be mild and partly too wet but mentions nothing special. During the months of July and August 1939, the weather in Northern

¹⁴ Gunton, 1938/39

Germany was regarded as too warm and too wet. A summary for September indicates that the month was a little bit too cold in the southern one-third of the 'Reich, and it was by far too wet from the upper and middle Rhine area towards Silesia (Schlesien). October was colder for the whole of the 'Reich' but extremely wet in the Southern part and dry in the North. November was generally too warm and too wet. December was generally too cold, but it was too wet only in Saxony and Silesia¹⁵.

The weather in Sweden during 1939

The start of the year 1939 was marked with mild winter weather with low wind cyclones and excessive rain. Spring months witnessed changing pressures with partly dry spells. The summer months were dominated by a low-pressure moving northeast, which brought along high precipitation to the Southwest of Sweden, in particular. Warm and dry summer weather appeared in August, when a high pressure dominated, which lasted through September. Then the weather became wetter and wetter with storms, which are usually rare during the season, becoming more frequent.

October, however, was characterized by several highs consequently making the weather relatively cold and dry. During the remaining months of the year there was a rather large number of lows, carrying along precipitation as well as storms. The last week of the year was marked by some lows – moving southeast – and brought along an exceptionally strong cold for the whole country¹⁶.

The weather in Switzerland during 1939

1939 was a very rainy year. In Zürich it was the year with the highest precipitation for the last thirty years. The sunshine was one third less than expected. For the last fifty years no other year had witnessed less sunshine as 1939. Only January and April had normal sunshine; farthest away from normal were May and October, which reached a degree of cloudiness like never before. Compared with these extremes the average annual temperature was quite normal. As to the 75 year average, the average of 8.8°C of 1939 even showed a slight increase in the level of warmth by about one tenth of a degree. Still, 1939 was the coldest among the past six years.

Source: Neue Zürcher Zeitung; Montag, 8 Januar 1940

It should be noted that the high precipitation is due to the heavy rain since the war started. The triangle Switzerland, France and Germany, e.g. Freiburg/Breisgau, had 30 rainy days in October 1939. (A)

¹⁵ Witterungsbericht

¹⁶ Statens

Further details: (A) Rain-Making, 2_31.

The missing west-wind

The flow of Atlantic air

General weather conditions in Europe are determined by the cyclonic west-wind climate, which is dominated by the movement of maritime air masses from west to east, most significantly during the winter season. German meteorologists called it west-wind-drift (WWD) until the 1940s. Particularly sensitive to the WWD are Northern Europe, north of the English Channel, the Alps and the Black Sea. Since sunshine is less during the winter months, heat stored by the ocean or seas contributes to Europe's usual mild winter weather conditions. For cyclones generated in the middle of the North Atlantic, south of Iceland, the common axis for going east would be via England, the North Sea and Northern Germany. As long as the flow of maritime air from the Atlantic is moving this way, the climate in Western Europe is moderate and the flow of continental air is reduced. This common climatic mechanism was considerably reduced in respect of all countries bordering the North and Baltic Sea in late 1939. Although the North Atlantic was not less active as usual, the low-pressure systems moved less and less along the common WWD.

According to the *Neue Zürcher Zeitung* (14 January 1940) the meteorological conditions for the early cold in January 1940 could be traced back to the first week of December 1939. (A) Indeed, on the 8th of December the situation was conducive for an early winter and presumably cold start into the winter season, when a solid high-pressure bridge stretched from Scandinavia to France (see map above). Such a situation cuts Middle Europe off from the weather making process in the Atlantic.

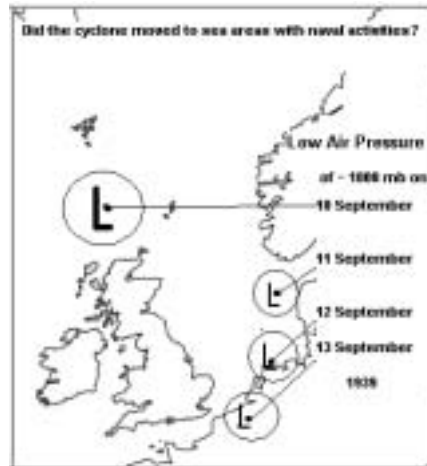
Further details: (A) above page 25.

It took only two weeks for Europe to enter into a very severe winter. The weather chart of the 21st December 1939 (see p. 35) showed that a high pressure with 1,033mb had taken position over Central Europe (Kassel), with three cyclones on the periphery; one the off Lofoten (970mb); one in the middle of the North Atlantic, south of Iceland (980mb); and one off the coast of Porto/Portugal (1,010mb). The corridor via the North Sea was definitely closed for some time. The 'too cold' water body formed a barrier preventing Atlantic air to flow along the common WWD. That this process had started much earlier than in December 1939 is discussed hereafter. This discussion is

based on the daily weather analysis of the German meteorological service, the “Seewarte”¹⁷.

Deviation from average? – September 1939 – First signs?

During the first few days of September 1939 the weather in Western Europe was influenced by a high pressure over Scandinavia. Except for a mixed front line (warm and cold) running from Bergen, Jutland, Basel, the Adriatic Sea, Malaga and out into the North Atlantic on September 5, the dominance of the high pressure remained until September 9 when a cyclone passed Scotland, entering the North Sea (September 11-13). The movement of the cyclone from Jutland, through the German Bight to the coast of the Netherlands and then to Brussels seems to have puzzled the analyst as recorded in his assessment on September 12th and 13th. At least, he spares no



efforts to explain this event. What this cyclone may show is that the WWD still remained functional two weeks after the war had started. Actually, the cyclone had been located south of Iceland on September 9th (1,005mb), Northwest off Scotland's coast on September 10th (1,005mb), moving via the Northern North Sea to Jutland (1,000mb) on September 11th. 'Normally' the cyclone would have moved via the Kattegat to the Southern Baltic, unless a significant temperature difference between the land (cold) and the water of the North Sea (warm) had attracted it to take the southerly route.

Remark: It could well be possible that the cyclone's movement was determined by military activities in the Helgoland Bight and the laying of large mine fields in the Middle of the North Sea (called: 'Westwall').

Further details: (A) Sea mines, 2_14.

¹⁷ Seewarte

During the next two weeks the daily weather charts show quite solid proof of the existence of a high-pressure area between Iceland and Scotland from September 16 – 28. Most significant comments of the Seewarte analyst are as follows:

19 September 1939; Cyclonic activities over the Polar Sea area (Nordmeergebiet) are intensive. The west-drift in the North will consequently move more and more to the South.

23 September 1939; With the advance of Atlantic air into Middle Europe a more forceful cyclone can develop along this channel (Rinne) which could extend its influence in the Middle Europe later.

Remark: The last two extracts show the high expectation that cyclonic activities in Middle Europe will resume soon, which did not occur as indicated in the following extract one week later.

29 September 1939; General weather situation towards the end of the month clearly reveals changes indicating the end of the Indian summer spell which leads to a time of increased cyclone frequency in Europe. In the weather chart this is indicated by a decline in the Northwest-European high-pressure area (anticyclone), which dominated the general weather for a long time. This high, that usually is located far to the East (cf. the weather situation a year earlier) is responsible for the well-known late summer period of fine weather, now pushed so far to the West that Germany lay at its Eastern rim and thus got into the cold Northern stream which was interspersed with disturbances.

The analyst wonders – October 1939

- Remark: When the month of October was over, the Seewarte analyst came to the conclusion (2 November 1939) that in the current year the west-wind-drift (WWD) of the temperate zones was very underdeveloped and was missing completely in Europe. It was not the first time that the daily weather analysis had given an indication about the weakness of the WWD in autumn 1939, e.g.:

13 October 1939; Along with a peripheral low, the first effective gust of maritime air has reached Northern Germany. A continuous WWD, however, cannot be expected yet.

19 October 1939; A broad high-pressure bridge has formed between the Atlantic and Scandinavia high. Again this results in a weather situation like those, which have been witnessed frequently before during corresponding months, viz. a high-pressure zone moving from the Atlantic via Southern

Scandinavia to Russia, with low-pressure disturbances to the North and South of it.

23 October 1939; Usual weather is changing now and the high pressure bridge which links the Azores high with the West Russian high is broken up. A transition to a west wind situation is on the verge of the German seas.



28 October 1939; Since a high pressure bridge from Middle Scandinavia to Scotland remains, a further stream of cold air from the Nordic Sea area (Nordmeerraum) is cut off.

End of October 1939; Analysis of the weather chart for November 2 reads as follows:

Germany lies in the South (Southern part) of the high-pressure area and mostly experiences winds coming from East till North (NE- directions), which is clearly shown by the climatic data for last October:

Hamburg reported winds from the North-Eastern quadrant on almost two thirds of the dates observed (33% easterly winds out of 65%) while North-Eastern winds accounted only for a quarter (26%) of several previous years' averages. Otherwise most frequent direction of the wind – South-West (24%) – accounted for 9% of all cases. Thus the observations at this station alone show what the weather charts of an extensive area will obviously indicate as well.

- Remark: This is a very strong and clear indication that huge air masses moved towards the North Sea, presumably caused by unusual high evaporation in this sea area. While the water of the North Sea was 'stirred and turned' the 'steam' rose upwards into the sky, causing air to flow in from Easterly direction, which subsequently prevented low-pressure systems to travel along the west-wind-drift channel via the North Sea and Central Europe into the eastern hemisphere.

November 1939 – Average not returned

Data for the next four weeks are mixed. Four statements made during the month may illustrate the situation as seen by the analysts who thought them worth mentioning at that time.

5 November 1939: It appears that now – like in many earlier years – a WWD with lively cyclone activities will begin to move over Europe at about the middle of the month.

14 November 1939; It seems that a mainly sectional circulation is going to take over in the general weather situation: its pressure field will be characterized by a long high pressure zone – Azores –Southern Germany – Southern Russia – and WWD-like turbulence activity in the North of these regions.

29 November 1939; West Siberian high is slowly retreating towards the East thereby allowing the disturbance coming from the West to penetrate still deeper into the regions of European Russia.

30 November 1939; A very distinct west wind weather situation rules over North and Middle Europe.

In summary the expectations of the weather analyst for ‘lively cyclone activities’ did not materialize. Seawater changes by devastating war machinery were not imaginable by weathermen then.

The drift is gone – December 1939 – The ice age returns

- Remark: The first few days of December see attempts by rather weak cyclonic storms to reclaim their common path of travel from the Atlantic to the Eastern hemisphere. By 7th December 1939 a high pressure forms near Aachen (West Germany/Belgium), stretching to Norway, the ‘last straw’ that led to a severe winter condition, as analysed by the Neue Zürcher Zeitung, and reproduced above, (NZZ, 14 January 1939). Four further excerpts from the daily Seewarte analysis demonstrate how the ‘Seewarte’ civil servant on duty judged the developments.

1 December 1939; Quite distinct Atlantic frontal zone of the last few days is disintegrating.

8 December 1939; It appears that the influx of warm air from the West is stronger than the retreating stream of cold air so that the high pressure bridge might stay, although the English frontal zone is currently progressing towards the East ever so slowly.

19 December 1939; A high-pressure ridge stretches....(etc). These conditions, however, are not likely to exist. The same pressure ridge is

attacked from two sides and has gained more than 10mb in the past 24 hours....



21 December 1939; A high pressure area that yesterday lay over the Northern coast of Scotland, lies today over Central Germany with a central pressure of 1,034 mb. The heavy fall in pressure over the Polar Sea area (Nordmeerraum) has produced a low there.

Since this date the West Wind Drift was defiantly barred from entering Western Europe.

Changed wind direction

The foregoing investigation stressed the significance of the observed change of wind direction in Hamburg during October 1939. Wind direction had dramatically changed from prevailing SW winds to dominating NE winds.

At this stage it might be worth noting the research made by Drummond¹⁸ for Kew Observatory (London) in the early 1940s, that of the prevailing wind directions in South-West England during 155 winters from 1788 to 1942 only 21 had easterly resultants whereby the few winters 1814, 1841, and 1940 had resultants from NE to ENE, meaning northerly than East. Another little number of winters since 1841 (1845, 1870, 1879, 1891, 1895, 1904, 1929) had prevailing SSE to ESE. With the exception of the winters 1801 and 1804 all of these 21 winters with predominant easterly winds had a temperature below average (40,1°F; 4,5°C). While eleven of the above winters had means between 34°F and 36°F, only few westerly resultants had means lower than 37°F, these being 1820, 1830, 1847, 1855 and 1886.

In summary it can be established, that winter 1940 clearly played in the league of the Little Ice Age, being the only winter with wind from the NE quadrant since the end of the Cold Medieval Age Period. That had little to do with distant El Niño but a lot with the just started war at sea.

¹⁸ Drummond

Comment

In December 1939, on the question whether the usual west wind situation was returning to normal, the analysts concerned may have become frustrated over the delay. On 19th December it was regarded certain that the ridge would cease, but the belief was in vain. The two low pressures may have looked strong enough to fulfil the task, but what the analysts did not know was that the regional seas were not able to act in unison. Only two days later Central Europe was solidly under the control of a high pressure bringing in air from Greenland or Russia's North. The North and Baltic Sea had lost too much of their heat capability to steer Northern Europe through a moderate winter. The coldest winter was due. (A) The war at sea made the seas bend the weather in Northern Europe according to its will, acting swiftly to stir and shake. (B)

Further details: (A) Winter 1939/40, 2_11; (B) North Sea cooling, 2_16, and Baltic Sea cooling, 2_17.

Conclusion

Development of severe weather conditions during the first war winter of 1939/40 was not an erratic incident by nature. This could be well illustrated by various comments on the missing “west-wind-drift” by meteorologists responsible for the preparation of daily weather charts. In the absence of usual weather behaviour, their task of making reliable weather forecasts was complicated. Direction and intensity of maritime air from the North Atlantic are particularly relevant in this matter.

The extreme cold wave in early January 1940 had hardly started when the Neue Zürcher Zeitung explained on 17th January that its formation could be traced back to the first week of December 1939, observing that high air pressure stabilised over Middle and Northern Europe, which kept Atlantic cyclones away from the continent. That was exactly what the people from the German weather service had been concerned about since October 1939. But their analysis on 29th September notes that they realised a significant deviation in weather from average condition. The high pressure for an Indian summer in Germany had moved extremely far away to the West. However, Germany was not on the Western border of the pressure system, but on the Eastern border. The move of the high pressure so far to the West stands in close relation with the churning of the seawater areas due to naval war in Northern Europe's seas.

War at sea 1939 - Facts and events (2_13)

Introduction

The theme

What caused the deep fall in winter temperatures and the consequent extreme weather conditions in Europe within just four months after the start of WWII? This study concludes that the cause for this must be attributed to changed seawater conditions in Northern European waters. (A) and the Eastern Atlantic including the Norwegian coast and the English Channel, due to war at sea. In these sea areas surface water and the water column below were most severely affected by ‘turning the sea upside down’ at many places thousands of times every day from the start of the Second World War on September 1st 1939. Every excessive mixing of the sea during autumn time has had an adverse impact on heat conditions of the sea area in question. “Forcing” warm surface water to greater depths will have its own consequence in the atmosphere. To “stir” the heat out of seawater earlier than it would otherwise happen naturally, must inevitably invite cold arctic air to invade earlier, fiercely and to make it stay longer. The result speaks for itself. Northern Europe plunged into the coldest winter in 110 years. (B) For three war winters the ‘axis of cold’ stretched from Stockholm to London.

Further details: (A) Baltic Sea, 2_17, and the North Sea (2_16); (B) Europe in arctic conditions, 2_11; (C) Three-year-package, 3_31.

Similarities



From the first day of WWII sea was ‘abused’ as never before. Something similar had happened only once before during World War One. Between August 1914 and November 1918 a modern sea mining and submarine warfare was waged to cut the enemy

off its supply lines. (A) In 1939 the combatants wanted to achieve a similar effect from day one of the war itself. Twenty years earlier when the war at sea became fierce in 1915, war winters of 1915/16,

1916/17 and 1917/18 had turned out to be very snowy and very cold as far as Britain was concerned. (B) Similarly, as in the previous World War, when fighting at sea in 1939 started seriously at hour zero, the winters of 1939/40, 1940/41 and 1941/42 had been extremely cold and snowy in respect of the British Isles. By comparison, in WWI, while war at sea took 16 months to provide Britain with an extreme winter; it took WWII only four months, not only to provide Britain a similar harsh winter again, but also to drag whole Northern Europe and the north of Switzerland into the coldest winter for 100 years. This proves beyond doubt the effect tremendous naval activities set in motion from ‘hour-zero’ with numerically higher, bigger and powerful equipment under, on and above the sea surface.

Further details: (A) War at sea 1914-18, 5_13, Sea mines 1914-18, and 5_14. (B) Europe weather WWI, 5_11.

The presentation

An overview of some of the events will be given here to provide a glimpse of what happened in Northern European seas during the first four months of war, i.e. September-December 1939. The focus of attention is on the ‘abuse’ and ‘shaking’ of the seas, consequences of which cannot be ignored while trying to understand changes that occurred in the winter weather conditions. This presentation does not in any way attempt to provide a complete picture of naval events, but will restrict itself to providing only a very random and small collection of facts and figures to underline the enormous activities that the seas experienced during a short time of only a few months.

The following text briefly presents a number of topics concerning the impact of naval activities on sea during the first four months of war in 1939, to be read together with two additional papers, one, relating to bombing and depth charging of U-boats, and the other describing the impact of sea mines on sea (A)

Further details: (A) Sea mines, 2_14, and Depth charging, 2_15.

Comparing these initial four months of war with those that followed the after end of the year 1939 with continuously accelerating military activities which caused tremendous stirring of the seas, make it appear that the role of the initial four months was almost modest. One of the principal aims of this study will be fulfilled, if it is able to establish that the war at sea had actually caused inordinate weather

developments within a short period of four months leading to the arctic winter of 1939/40 in Europe.

Some general data

Naval Fleets



On 1st September 1939 the number of main naval ships belonging to Germany, Great Britain, France, Italy, the Soviet Union and Italy amounted to more than 1,000 vessels (including submarines, torpedo

boats) with a total tonnage of 2.8 million. Additionally there were about 400 smaller naval vessels (e.g. mine-sweepers) with a total tonnage of 350,000 as mentioned below:

- Great Britain: 250 big naval vessels, (183 destroyers and bigger vessels) and ca. 57 submarines;
- Germany: 30 big naval vessels (21 destroyers and bigger vessels), and ca 12 torpedo boats and 57 U-boats.

Depth Charges

“During the first six months of war an estimated number of 33 U-boats were destroyed in about 4,000 depth charge attacks”¹. “Once a submarine is located, British naval plans, so far as they were known before the war, call for attack by familiar methods of an enclosing diamond pattern of depth bombs”, explains the New York Times (NYT 16 September 1939) on the procedure for attacking U-boats. Each attack possibly could mean a few to many dozens of depth charges. The total number of depth charges dropped per month could easily reach the figure of 10,000. During the first four war months 20,000 to 40.000 explosions could have occurred below the sea surface. (A)

Further details: (A) Depth charging, 2_15.

¹ Hackmann, p.303

Ships; Available and Lost

Tonnage of British ships available in 1939: ca. 18 million tons, ca. 7,000 vessels, ca. 27% of world tonnage. The German merchant fleet was a quarter with 4,5 million tons. The world fleet in 1939 comprised 30,000 ships with about 70 million tons.

Summary of British, Allied and neutral ships lost in UK waters:

- September 1939: 33 ships of 85,000 tons
- October 1939: 24 ships of 63,000 tons
- November 1939: 43 ships of 156,000 tons
- December 1939: 66 ships of 152,000 tons.

(source: www.navalhistory.net/WW2CampaignsWFront1939.htm)

British naval vessels lost

One battle ship; three destroyers; one aircraft carrier; one armed merchant cruiser; ca. 10 trawlers; two U-boats; and others.

Some warfare aspects

British Naval “Cavalry” Riding the Sea

The sea around Britain was ploughed by a naval flotilla from day one of WWII. Mr Winston Churchill supported the naval tactic. A group of three to five naval vessels would systematically search large areas of sea ‘like a cavalry division’ and guard sea-lanes². Especially the Navy’s few and precious aircraft carriers with an escort of destroyers were put into action during the early days of the war. Thus, at any time, thousands and thousands of miles of sea were criss-crossed by a number of British naval flotillas searching for enemy U-boats, dropping depth charges whenever a threat was suspected, real or assumed. The number of depth charges dropped during the four war months of 1939 was never counted. It could have been many thousands.

Enormous search activities to detect and destroy U-boats that “stirred the sea” around the



² Winton, p.130

British island find little mention in naval historical essays. These activities without any military results were quickly forgotten, although their impact on the “summer heat storage” position of the sea remained significant. The work of the ‘Cavalry’ was recorded only if something happened; either success or doom, both had great impact on the sea. The following two cases are shown as examples from the first month of war to illustrate a similar situation.

On 14th September 1939: U-39 operating off the Hebrides shot its torpedo at the 22,000-ton aircraft carrier ‘*Ark Royal*’, but missed. Escorting destroyers *Faulkner*, *Foxhound* and *Firedrake* depth-charged U-39 in a series of attacks. U-39 surfaced briefly and sank. The crew was captured³.

However, the next U-boat attack succeeded. The 22,000-ton British aircraft carrier ‘*Courageous*’ was on an enemy hunt along with four destroyers in the Southwest approaches (Southwest of Ireland), 150 nautical miles WSW of Mizen Head, Ireland, in the early evening of 17th September 1939. The carrier could travel at a speed of 30.5 knots (56 km/h). But HMS *Courageous*’ days were numbered. “A German submarine struck a telling blow at the British Navy last night by sinking the 22,000-ton aircraft carrier *Courageous*, with loss of an unknown number of her complement of 1,100 officers and men. It was the first real success scored by the German Navy in this war.” (NYT, 19 September 1939).

She was attacked by U-29. From a salvo of three torpedoes the *Courageous* was hit at portside by two. The destruction was devastating as described by Sub-Lieutenant Charles Lamb:

‘There were two explosions, a split second apart, the like of which I had never imagined possible. If the core of the earth exploded, and the universe split from pole to pole, it could sound no worse... In the sudden deathly silence which followed I knew the ship had died.’

The *Courageous* turned over and sank within fifteen minutes, with loss of 519 of her crew⁴. Lieutenant Wesmacott ‘heard two violent explosions which seemed to lift the ship’. (NYT, 19 September 1939).

Another crewmember reported: “Then the order to “Abandon Ship” was given by the Captain. I waited a few more minutes and then took the last of my clothes off and dived in. I swam out in the direction of the destroyer. After about fifty yards I turned and saw the last of the ship as she went under. After that I was swimming and catching hold

³ Winton, p.129

⁴ Winston, p.129

of pieces of wood for about 45 minutes. The water was black with men and oil, of which I drank mouthfuls!”

Other ships hurried to the spot where *Courageous* went down and assisted in the rescue operation. Survivors reported that destroyers scurried over the water after the submarine and it was believed that one of the depth charges they dropped sank the U-boat (NYT, ditto). However, that was not the case; U29 returned to its home base safely.

“The night was dark, weather fine and the sea smooth”, survivors said. Visibility was described as moderate’ (NYT, ditto).

Hunting German vessels

The Royal Navy formed small groups of naval vessels to control traffic (Northern Patrol) and seize enemy vessels. Within the first 6 weeks, about 300 vessels were controlled and more than 60 brought to the port of Kirkwall/Orkney.

The ‘diamond pattern’

The New York Times reported in September 1939 on procedures for U-boat hunting as follows: “Once a submarine is found, British naval plans, so far as they were known before the war, call for attack by familiar methods of an enclosing diamond pattern of depth bombs, supplemented, of course, by shell fire and ramming if the submarine could be forced to the surface. In the diamond-pattern attack, the destroyer goes at full speed for the spot where the submarine, slow and clumsy under water, is thought to be. One depth bomb is let go just before the spot is reached. A few seconds’ later two more are lobbed out by a Y-gun so that they land out on either side of the destroyer’s wake. The forth point of the diamond is another depth bomb dropped over the stern some distance ahead of where the Y-gun fired. In this way a large area of the sea is covered by the diamond pattern. The effect is further increased by the fact that the bombs are timed to go off at different levels, so that the area is covered not only horizontally but vertically as well. The bursting area of a modern depth bomb is considerable”. (NYT, 16 September 1939).

Arming the merchantmen

By the end of September 1939, Churchill said that 2,000 ships would receive guns (NYT, 1 October



1939). Within twelve months after the outbreak of the war 3,000 vessels were armed. The key defence was a 4.7 inch gun⁵. A story about the heroic act of gun personnel in 1939 reads as follows: “As *Culebra* sank ‘in a heavy cloud of smoke and steam’ the survivors, which included her six gunners, took to the remaining lifeboat. Sadly, no one survived the gale which sprang up twenty-four hours later”⁶.

Minesweeping

Minesweeping became a pressing issue for the major countries at war. Particularly Britain needed an effective force for minesweeping operation. The naval minesweeping branch requisitioned some 800 trawlers, drifters, whalers and fishing vessels. In December 1939 it was indicated that more than 100,000 men would be engaged in the sweeping of German mines in British sea-lanes. (NYT, 10 December 1939). By the end of the year the sweeping force consisted of a

searching force with 150 trawlers and 100 drifters, and a clearing force with 16 fleet sweepers and 32 paddle sweepers⁷. (A)



Further details: (A) Sea mines 1939, 2_14.

Convoy

Sending merchantmen in convoys escorted by naval forces had been proved very successful during WWI. ‘The previous war had proved the sovereign merits

of convoy’, Winston Churchill had acknowledged. Implementation of the convoy system in 1939 went quite smoothly. The first convoy of eleven troop transporters sailed on September 5 from Clyde for Gibraltar, escorted by the battleship *Ramillies* and eight destroyers. By December 1939, 5,756 ships had sailed in convoys⁸. By year’s end only twelve vessels in convoys and five stragglers from convoys were torpedoed by U-boats and sunk, with a total tonnage of 421,156 tons⁹.

⁵ Slader, p. 56

⁶ Slader, p.57

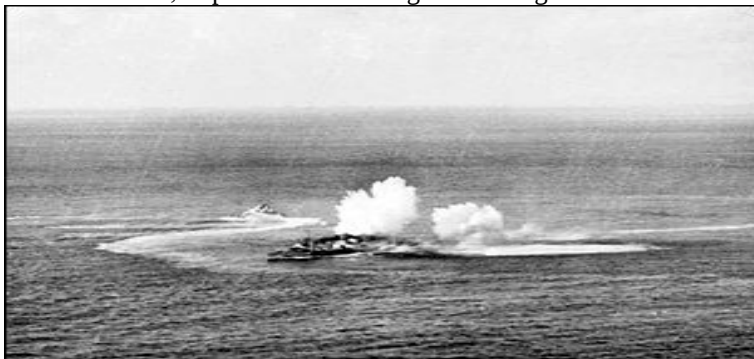
⁷ Elliot, p.31

⁸ Winton, p.128

⁹ Winton, p.130

Aerial bombing and mining

Neither the German navy nor the British had a fully operational aerial arm at the start of the war. The German Navy never got one. British Royal Air Force Coastal Command became operational sometime in 1940. However, airplanes for bombing and mining missions were



operating frequently, the British planes in the Helgoland Bight and the German on England's East coast. On September 3, 1939, Britain possessed an operational strength of 2,600 aircraft¹⁰; and the Germans presumably not less. (A)

Further details: (A) Bombing and depth charge (2_15).

Summary

Even though historical information have been written down abundantly, little has been said on the impact naval and military activities have had on seas and estuaries during the first few months of war. The temperature condition of ocean and seas determine weather and climate. This paper demonstrates that from the first day of WWII the war at sea had turned about large areas of Europe's seas. (A) At least the winter of 1939/40 responded to the changed seawater status in the North and Baltic Sea and succeeded in bringing arctic conditions to Europe during the winter 1939-40. (B)

Further details: (A) On sea-mines, bombing and depth charges, 2_14, and 2_15; (B) Arctic winter 1939/40, 2_11.

¹⁰ Sauders, p.379

Sea Mines September – December 1939 (2_14)

Introduction

Sea mines and weather modification

Sea mines, bombs planted at different levels under the sea surface, are an excellent means for a magnificent experiment to study weather modification. As oceans are huge, one certainly needs more than a few mines for proper effect. But if the experiment is more confined, let us say to the North Sea and Baltic Sea, any result may become visible and be felt quickly. Something of this nature happened in late 1939. Within a period of just four months after parties to the war had planted thousands and thousands of mines in the North Sea between Scotland, Dover and Skagerrak and in the Baltic Sea, Northern Europe experienced an extremely cold winter. This is not the only surprise. In the Netherlands and North Germany, immediately adjacent to the German Bight and Southern Baltic Sea, where the bulk of the mines had been laid in autumn 1939, the winter was the coldest in more than 100 years. About 100 to 300 years ago, Europe and the northern hemisphere had been in the icy grip of the so-called 'Little Ice Age'. Suddenly the period before 1850 returned.

Using sea mines as a weapon



During WWII Allies and Axis countries laid about 600,000 sea mines in European and Atlantic waters. While comparing mining activities during the period of four autumn months of 1939 and those 65 months that followed from 1940 to 1945, one may tend to think that this short

period of four months is hardly significant and can be summarily ignored. That would be wrong for the following reasons:

1. During the first four months of war the 'monthly-average' of mines laid was possibly 10 times higher than during the next five years and could have been in the range of between 50,000 to 100,000 or more, due to the fact, that

- a. the countries could immediately use their accumulated stockpile,
 - b. sea mines were regarded as ‘cheap’ weapons and it was not difficult to produce them in large numbers,
 - c. neutral countries also could and did use mines as a ‘defensive measure’.
2. At the time WWII started in September 1939, the oceans and seas were in their “natural status”. But the exploding of sea mines and other military activities as the war progressed through days, weeks and months, interfered with the ‘common processes’. And within a month of the start of the war, sea areas in question lost their ‘common seasonal average’, as it had existed before.

For reasons stated above, while discussing the issue of sea mines, only the period from September to December 1939 will be covered here. However, heavy impact of the war machinery on European waters will be dealt with in two further chapters elsewhere. (A)

Further details: (A) Sea war events 1939, 2_13; and Depth charging 1939, 2_15.

Mining the North Sea (September - December 1939)

England's east coast

British mined their East coast from Dover to the Orkneys successfully during the first few months of war. In September 1939 alone, the British minelayers *Adventure* and *Plover* planted 3,000 mines across Dover Street (English Channel). In the second half of September the barrage was completed by 3,636 U-boat mines, consequent to which Germany lost three U-boats in October¹.



The British set up the East Coast Barrier, a mine barrage between

¹ Rohwer

twenty and fifty miles wide from Scotland to the Thames, leaving a narrow space between the barrage and the coast for navigation. In late 1939 the British Admiralty intended laying a 500-mile minefield of unprecedented size, a barrage in a strip of thirty to forty miles. That was a “gigantic effort to check the German submarine campaign”. (NYT, 31 December 1939).

Even though it is difficult to verify the number of mines laid by the British in the North Sea immediately after commencement of the war, the total number of mines laid during autumn 1939 would certainly have crossed 10,000. Presumably the number was much higher, if one can rely on a report by the NYT in early January 1940. : “British naval vessels are sowing some of the last mines needed to complete Great Britain’s 30,000,000-pounds protective shield for east-coast shipping. The minefield extending from Kinnairds Head, Scotland, almost to the mouth of the Thames, is the most extensive field ever laid.” (NYT, 11 January 1940). If one assumes that the weight of those mines varied between 300 and 1,200 pounds, the number of mines laid in autumn along the east coast alone, would be between 25,000 and 100,000 mines.

Helgoland Bight (Deutsche Bucht)

German Navy engaged in planting contact mines probably much more actively from Holland’s coastal waters (off Terschelling) northwards across the Helgoland Bight up to the entrance of the Skagerrak, at a distance between 50 and 100 km off the coast of Schleswig-Holstein and Denmark, called “Westwall”. The most north-westerly point announced by the Germans as ‘Dangerous zone’ was the position: 56° 30’ North and 4° 25’ East. That was about half the distance between Skagerrak and Scotland. The first minefield locations were off Terschelling, Esbjerg, near Helgoland and two places off Jutland. (NYT, 5 September 1939). Specific warnings had been given to more than 100 Danish fishing cutters from Esbjerg. (NYT, ditto). It was reported that one unidentified cutter had been blown up seventy miles west of Wyl light ship. (NYT, ditto). For about three weeks a flotilla of at least 25 naval vessels was engaged in laying mines along the “Westwall”.

It was difficult to verify how many mines the flotilla had planted within the first few weeks, as it was not possible to get reliable figures about the stockpile the Germans had on September 1st. The number of mines laid during the period in question could be as few as 20,000 or as many as 200,000. But as the distance from Terschelling to 56° 30’ North is about 350 kilometres (170 sea miles) and as the deployed 25

naval vessels were able to put in place several thousand mines per day it seems reasonable to assume that, by the end of September at least the first 10,000 mines and by the end of October 20,000 were in place and the “Westwall” was more or less completed in the following months. According to a report by the NYT – Magazine, as many as 300 mines an hour could be laid by one minelayer. (NYT, 18 February 1940). From the total of more than 200,000 sea mines the German Navy used in WWII, presumably one-third of the total would have been laid in the North Sea during the early days of the war.

In a number of missions Home Fleet’s surface vessels laid mines close to the Axis shipping lanes and channels, e.g. the British destroyers *Esk* and *Express* laid mines at assumed ‘exit channels’ close to the “Westwall” as early as mid September², while the British East Coast was frequently supplemented with contact mines laid by surface vessels and magnetic mines laid either by German naval vessels, U-boats or air planes.

Mining along the West coast of Britain, 1939

The Home Fleet organised the laying of a number of mine fields on the Atlantic coast of Great Britain and the English Channel, e.g. in the Northern Channel (north entrance of the Irish Sea), at the entrance to Liverpool, Cardiff, Plymouth, Southampton and the Eastern part of the English Channel (Isle of Wight, Le Havre, Dover). (NYT, 17 December 1939, section 4).

Mining the Baltic Sea, 1939

War had just started when 1,555-ton Greek ship *Kosti* hit a German mine two miles south of Falsterbo/Sweden on 4th September and a “terrific explosion was reported in the minefield south of the Great Belt, west of the Danish island of Zealand”. (NYT, 5 September 1939). The Danish Government announced plans to plant mines in its waters. (NYT, ditto). Actually, the Germans laid about 1,000 mines on September 4th at the entrance to the Danish waters, the ‘Belts’. Mine laying continued. The situation worsened day-by-day for six long years. How many mines the Germans planted in the Southern Baltic is difficult to verify. In the Western Baltic it would have been many thousands before the winter of 1939/40 arrived and as a result the German Baltic waters fell prey to a compact ice cover.

² Rohwer, 09 Sept.39

Other riparian countries planted mines as well. Even the hard pressed Poles with the help of minesweepers *Czajka*, *Jasolka* and *Rybitwa* managed to drop 60 mines south of Hela (Gdanska Bight) on September 12th. The Soviet Navy started laying mines in the Gulf of Finland in late September, which also saw a number of mining activities by Germans, Finns and Russians during November and December 1939.

Further details: A fairly detailed account of what had happened in the Gulf of Finland when the Soviet Union invaded Finland in December 1939 is given in the paper: Russian-Finnish war, 2_41.

Minesweeping and Countermeasures



Explosion of mine in Baltic Sea

Minesweeping is the task of detecting implanted mines and making them harmless in a variety of ways including blowing them up with explosives.

A standard mine in WWI and at the start of WWII was the moored contact mine, a buoyant material filled with explosives of up to 1,000 kg. To nullify their effect special ships used distant means to cut the mooring chain or wire attached to the mines to float them. Sometimes they exploded before reaching the surface but if it surfaced it was blown up by rifle shots.

Germans used magnetic mines for the first time in November 1939. The NYT soon reported that: “Some wild stories have appeared here suggesting that the Germans have invented a so-called ‘magnetic mine’”. (NYT, 22 November 1939). Actually, one magnetic mine was discovered on the shore near Southend on November 22nd and was examined by the Navy’s mining school³. Only two countermeasures were available against magnetic mines. One was to explode the mine by towing a cable, which passed an electric current through the water. From the point of view of climate, this was the worst possible result.

³ Elliot, p.30

The mine exploded at its location, at a depth of 20, 50, 100 metres or more, producing the highest possible “stirring” effect in the water column above. The other countermeasure was to deactivate the ship’s ‘magnetism’ so that it could pass near the mine without activating it. This may have saved the ships in a few cases, but the mine remained a threat until it exploded later or until it was deactivated mechanically⁴.

The same was the case with Oyster mines, which were equipped with pressure mechanisms and were first used by Germans off Normandy and Cherbourg in 1944. Sweeping them in WWII meant exploding them by countermining. Limiting the ship’s cruising speed to less than four knots gave them some protection.

British Navy mostly used antenna mines, mines that can be planted at any depth and from which long thin copper cables supported by small metal buoys reach up to within a few feet of the surface. These exploded when a submarine (or metallic body) touched the antenna, thus making it unnecessary for the submarine to strike the mine itself. (NYT, 31 December 1939).

Mines, while exploding mix a column of water within seconds. Sweeping for mines proved to be a tremendous round the clock operation travelling millions and millions of miles in the sea for detecting and destroying the ‘weapon in waiting’. The efforts made during WWII had been tremendous. German Defence machinery against Allied mining involved 46,000 personnel, 1,276 sweepers, 1,700 boats, and 400 planes, whereas the British Defence against Axis mining involved 53,000 men and 698 sweepers⁵. When on November 19th, 1939 five ships were destroyed by mines the urgent need for a huge mine sweeping operation became obvious. (NYT, 20 November 1939). The discovery of a ‘sample mine’ on November 22nd confirmed the effectiveness of countermeasures significantly. The British Admiralty quickly put a pre-war plan into action, whereby 800 commercial trawlers, drifters and whalers were requisitioned, fitted out with wire sweeping gear and their crews trained accordingly⁶.

What did the Mine Warfare do to the Weather?

At this point one can skip explaining the principal threat: ‘stirring’ the sea by exploding mines as well as effects of either throwing or eliminating mines by surface vessels. Such events coupled with the sinking of vessels with resultant pollution caused by cargo of the

⁴ Hartmann, p. 127

⁵ Hartmann, p.244

⁶ Elliot, p.30

doomed ships, would have changed the ‘common status’ of the sea, and thus the general ‘blueprint’ for the weather. The pre-winter months are particularly sensitive in storing summer heat or losing it prematurely by storm, wind or war activities. The mechanism of heat storage and release seems obvious. The question is how many mine related events have occurred during the pre-winter months, i.e., September to December 1939 that affected the composition of the weather?

The number of ships, sunk by mines until the end of 1939, was significantly large, but the exploding mines involved in the sinking of about 200 ships alone would hardly have raised great concern. The number of mines



exploded due to mine sweeping operations (see previous paragraph) is actually much higher. It is a fact that mines often tend not only to be “weapons in waiting” but also a “weapon that dies lonely”, either by mere erosion or explosion due to other reasons than war. In both cases, actual numbers are not available. If mines exploded prematurely during laying procedure, the information rarely left the inner circles of the Navy concerned. If mines exploded due to stormy seas, bombing or drifting ‘the matter’ will go totally unnoticed or go on record only in a few cases. A few examples of such cases are mentioned below:

- The US *Mormachawk* sailed with pilot assistance through a German minefield in early September 1939 when five loose mines blew up 500 to 800 yards away. (NYT, 20 September 1939).
- There were unexplained explosions around the East Coast of England, which were later discovered to have been magnetic mines going off prematurely. Casualties became so serious that at one stage Thames at Southend was closed for 36 hours, and Humber for two days⁷.
- “Gales have loosened several hundred mines in the German mine field... drifting mines exploded on the coast near the suburbs (of Copenhagen)... So many mines are floating around that it is impossible to destroy all of them due to bad weather.” (NYT, 6 November 1939).

⁷ Elliot, p.31

It will be never known as to how many mines exploded during storms, bombing, shelling or drifting cargo or wrecks in large mine fields like the German North Sea “Westwall”, and along England’s East Coast barrage with possibly several ten thousand mines. However, it will be significantly higher than any data on ship-sinking and mine sweeping would suggest.

At the end of the war when great efforts had to be made to clear the sea of mines, it was observed that about 85% of the mines laid had “disappeared” due to various causes and only a small fraction could be found and eliminated, either by explosion below surface or at sea surface⁸.



The following List of Events, even though in no way comprehensive, gives a brief account of how mine warfare was resorted to in the North and Baltic Sea in late 1939. A full picture would possibly require the reproduction of thousands of reports relating to stirring, shaking and mixing of Northern European waters.

Some Mining Events during late 1939

The purpose of the following list of events is to give a brief illustration of what happened in the first few months of WW II, how they contributed to changes in weather conditions of the North and Baltic Sea so much that an extremely cold winter could grip Europe and provide Central Northern Europe with the coldest winter in 110 years. It is a fact that the use of a huge number of sea mines from the first day of war together with other naval and military activities such as patrolling, shelling, anti-aircraft fire, bombing, depth-charging, and such other measures that turned the sea ‘upside-down’, has significantly contributed to the break-in of arctic conditions.

3 September 1939: North Sea (Helgoland Bight); The German navy commences laying contact mines from the Dutch island Terschelling 150 sm (ca 277 kilometres) north with 5 cruisers, 16 destroyers, 10 torpedo boats and 3 mining ships⁹. The mining field is called the “Westwall” as an imaginary extension of the “Westwall” stretching from Basel/Switzerland along the river Rhine to the northern border of Holland with Germany. The first mining activities lasted until 20

⁸ Elliot, p.193

⁹ Rohwer

¹⁰ Elliot, p.30

September. Other mining missions were undertaken at the same time (e.g. laying of the ‘Martha mine barrage’, as part of the North Sea ‘Westwall’). Exact figures of the number of mines laid in the first three weeks or in subsequent missions are not easy to establish. According to Elliot, the Germans were thought to have started the war with a stock of 200,000 moored mines¹⁰. This figure seems a little bit too high. As the previously mentioned flotilla was able to manage the laying of up to 3,000 mines per working day, it seems possible to lay of 20,000 to 50,000 mines within a period of three weeks’.

04 September 1939: “Danish Government has decided to place mines at the entrance to Mongedybet, Hollaenderdyet and Drogden. The purpose is said to be facilitating control of these waters”. (NYT, 5 September 1939).



3-9 September 1939: Four U-boats drop magnetic mines in the estuaries of Orfordness, Flamborough, Hartlepool and the Downs drowning four vessels with a total of 16,000-tons and damaging one ship of 11,000-tons¹¹.

10 September 1939: The British destroyers *Esk* and *Express* laid an offensive mine barrage on assumed German shipping channels along the „Westwall“¹².

4-20 September 1939: Baltic Sea; Several naval vessels prepared minefields, with at least 1,000 mines in the Western Baltic to control the Danish waterways to Kattegat and Skagerrak, in which the Greek ship *Kosti* hit a mine and sank on 4 September¹³.

8 September 1939: The Dutch Navy loses the minelayer *Willem van den Zaan* (1,270-tons) and the minesweeper *Willem van Ewijk* (460 tons) to its own mines¹⁴.

¹¹ Rohwer

¹⁴ Rohwer

¹² Rohwer

¹⁵ Rohwer

¹³ Rohwer

¹⁶ Rohwer

11 September 1939: “The German Government has broadcast a warning to all ships to stay out of three dangerous zones near the entrance to the Baltic. ...The announcer said that the second and third zones must not be entered at all and the first only behind a pilot ship. Presumably these zones have been mined.” (NYT, 11 Sept.39).

12 September 1939: Baltic Sea; Polish minesweeper *Czajka*, *Jasolka* and *Rybitwa* throw 60 mines south of Hela, near Gdansk¹⁵.

11.-16 September 1939: British minelayers *Adventure*, *Plover* and support vessels laid 3,000 mines across the Strait of Dover¹⁶.

21 September 1939: Soviet Navy plants mines in Gulf of Finland to protect Kronstadt and Leningrad. (NYT, 22 Sept. 1939).

25 September – 23 October 1939: U-boat sea mines barrage with 3,636 mines is laid across the Strait of Dover (between Folkestone and Cap Gris Nez). After three U-boats were lost in October 1939, no further attempts were made by U-boats to reach the English Channel through the Strait of Dover¹⁷.

October 1939; North Atlantic: Britain places 2,600 mines between Orkney, Faroe and Iceland¹⁸. Presumably, the actual number (for 1939) could have been much higher, as Britain laid 110,000 Mk XX mines between Orkney and Iceland between 1940-1943¹⁹.

16 October 1939 „A report from Falsterbo, Sweden, today said that a German pilot boat was blown up south of Oresund when it struck its own mine.“ (NYT, 17 October 1939).

17 October 1939: Mine operation off Humber by German torpedo boats and destroyers sank seven vessels²⁰.

21 October 1939: On 21st October and 25th November own mines sank German Coast Guard ships south of the Great Belt. (NYT, 26 November 1939).

6 November 1939: Off Copenhagen shore: “Gales have loosened several hundred mines in the German mine field... drifting mines exploded on the coast near the suburbs (of Copenhagen), breaking windows and frightening citizens with their terrific detonations. Naval

¹⁷ Rohwer

¹⁸ Ledebur p. 191

¹⁹ Hartmann, p.241

²⁰ Rohwer

²¹ Rohwer

²² Rohwer

²³ Rohwer

crews have destroyed no fewer than forty-three mines from Koege Bay up to Amager Island, where 100,000 Copenhagen residents live in a district comparable to Brooklyn. Along the whole southern coast mine alarms often make it necessary to evacuate villages while experts empty or explode the mines. So many mines are floating around that it is impossible to destroy all of them in the bad weather.” (NYT, 6 November 1939).

12 November 1939: North Sea; in two different missions a total of seven German destroyers undertook mining operations off the central Thames delta, resulting in the sinking of two destroyers, one trawler and about 20 cargo vessels, respectively ca. 60,000 tons²¹.

18 November 1939: North Sea, Humber Estuary, the mines of three destroyers sink seven ships with a tonnage of about 40,000²².

20 November 1939: Magnetic mines are flown and dropped by German Navy planes on British shores for the first time²³.

21 November 1939: Danes mine sea way; (NYT, 21 November 1939).

22 November 1939: Thirty-nine drifting mines seen near England (NYT, 23 November 1939).

23 November 1939: Mines sink 22 ships in six days. (NYT, 23 November 1939).

1 December 1939: England claimed to have mined an area of 300 square miles midway between the Schelde and Thames estuary. The freighter *Sheaf Crest* of 2,730 tons struck a mine and sank at a south coast town. (NYT, 1 December 1939).

December 1939: British East coast, numerous mining operations by U-boats sinking ca. 7 vessels²⁴.



²¹ Rohwer

²² Rohwer

²³ Rohwer

²⁴ Rohwer

²⁵ Rohwer

3 December 1939: “A British tanker was sunk by mines off the southeast coast of England.... She (*San Calisto*, 8,010-tons) struck two mines, which went off with such a force that the blast shook buildings on shore”. (NYT, 3 December 1939).

4 December 1939: “More than thirty mines were washed ashore on the Netherlands coast today, but were exploded by military patrols without damage”. (NYT, 4 December 1939). “Mines and wreckages washed ashore on the Netherlands coast on weekend. Westerly storms were silent witness to the naval war raging outside the three-mile limit. Many mines exploded on shore, but strict precautions taken by the Netherlands authorities prevented casualties”. (NYT, 5 December 1939).

4 December 1939: “A third German mine patrol ship was blown up this afternoon north of the mine fields off Denmark. German ship sank in less than two minutes, her entire bottom blown up”. (NYT, 5 December 1939).

5 December 1939: German cruiser *Nürnberg* lays mines off Kristiansand/Skagerrak²⁵.

6 December 1939: Sweden mined her waters opposite of Aland Islands. (NYT, 6 December 1939).

6 December 1939: Two destroyers drop mines off Comer, sinking two ships, damaging another²⁶.

6 December 1939: German naval motor gliders drop 27 mines in the Humber and Thames estuaries²⁷.

11 December 1939: Russians claim that they have cleared the Finnish



²⁵ Rohwer

²⁶ Rohwer

²⁷ Rohwer

²⁸ Rohwer

port Petsamo (Barents Sea) of Finnish mines. (Hamburger Anzeiger, 11 December 1939).

12 December 1939: Two days of German mining missions off Newcastle by five destroyers resulted in the sinking of 11 vessels with a total tonnage of ca. 19,000 tons²⁸.

14 December 1939: "Seven crew members of the Swedish battleship *Manligheten* were killed today in an explosion while investigating a floating object in the vicinity of Goeteborg....A small boat was sent to retrieve the object. Suddenly there was a terrific explosion." (NYT, 14 December 1939).

17 December 1939: Four British destroyers laid 240 mines in the river Ems delta²⁹.

30 December 1939: The small village of Huisduinen near Helder was severely affected by a drifting mine, presumably of Netherlands, which exploded on being washed ashore at 7 o'clock this morning". (NYT, 31 December 1939).



Minelayer

²⁹ Rohwer

Extract from „Climate Change & Naval War – A Scientific Assessment 2005
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Summary

Even a small record of mine operation events during a short time period of the initial four months of war, viz. September – December 1939, would give a strong indication of the enormous forces that began to interfere with the marine environment. This happened thousands of times each day. The sea was ‘turned upside-down’ at innumerable locations. In September 1939, military activities either increased evaporation, or forced warm surface water into depths. Later in autumn the war machinery reversed the process, forcing cooled surface water down and warmer water up. (A) However, due to their shallowness the Northern European seas have only a limited heat storage capacity. Once the heat is taken out, a maritime winter climate is lost as well. This happened in the first war winter of 1939/40. Consequently, since the first week of January 1940, Northern Europe had gone back into the ‘Little Ice Age’. (B)

Further details: (A) Cooling the North Sea; (B) Northern Europe plunged into arctic conditions, 2_11.

Bombs and depth charges at sea (2_15)

The Theme

While considering naval forces in action, one would primarily think of naval surface vessels fighting with each other with roaring canons in a sea battle with thousands of fountains of water springing up from the sea due to impact of shells hitting the sea surface, and of battleships opting to sink heroically in the rough seas along with their commanding admirals and soldiers. Even a layperson now knows that war at sea had already shown many other dimensions in the previous century itself. However, the general image of a sea battle demonstrates that fighting at sea can disturb water layer of quite a large sea area, e.g. Battle of Jutland (Skagerrak) in May 1916. 250 naval vessels gathered there and operated in an area of about 2,500 square miles. But neither WWI, nor WWII saw many such events. Warfare at sea came to rely more on sea mines, submarines and counter measures to meet the goals, i.e., the sinking of ships. (A)

Further details: (A) Concerning WWI, War at sea, 5_13 and Sea mines 5_14.

Means of warfare increased

With the start of WWII navies had a fairly new means at hand, i.e. aerial bombing of floating or submerged vessels and use of depth charges to hit submarines. The impact of sea mines, bombs and depth charges had a considerable impact on the status of seawater in affected areas. Further, one should not ignore the third activity, i.e. the shooting and shelling of fighter planes or bombers with all the firepower coastal batteries and vessels with guns had in their possession, as a preventive measure against being attacked or bombed. In the course of a war at sea, millions and millions of ammunition, ranging from small to big calibre, would inevitably hit the sea.

Compared with the potential above mentioned two means, bombing and shelling, had developed during the war, their deployment at the start of war in 1939 was more restrained. Parties to war were not very well prepared for using airplanes in naval warfare and depth charges to fight submarines when war commenced. While Britain managed to set up an effective 'Royal Air Force Coastal Command' to go for the German U-boats and to undermine German merchant shipping in North-West European waters fairly soon after the war had started¹, Germans never managed to create an effective aerial wing for their navy. Existing German naval air force was small, poorly

¹ Goulter, p.111f

² Goulter, p.37

equipped and remained insignificant. German Navy therefore had to depend on the Luftwaffe and its chief, Hermann Goering, who zealously exercised his command over all Luftwaffe units that might be compelled to support naval operations². Even though air forces of both warring parties were active from the first day of war, they did not play any major role in naval warfare in 1939. Such being the case, one might wonder how much this section of war machinery actively or passively contributed in ‘stirring’ the seas during the autumn season of 1939. Similar uncertainties existed with regard to the number of depth charges used and their locations. However, one thing became already very clear during the initial few months of war. Military forces had grown tremendously since last major war, viz. WWI, as if a breeze had developed into a hurricane.

As it is common knowledge, there exists a mixed layer of water at the surface of the seas, from a few meters up to a maximum of a hundred meters depth, which is stirred by surface winds. However, military activities can turn huge sea areas into mixed layers quicker than winds.

Presentation

Impact caused to seas in a sea battle with bombardments by airplanes and firing by battle ships and coastal batteries can only be imagined. How many bombs and shells ‘stirred’ the sea? How much explosives blew up? How many missions were carried out? None of the above questions can be answered here in detail, as such information is rarely available. The first four months of war can be regarded as a mere ‘military warming up’ phase. It certainly was, as far as aerial warfare is concerned, even though aviation had made considerable developments since WWI.

The question remains as to what restraints or precautions should have been observed by participants in the war in order not to drive the winter weather into arctic condition? The answer is left to everyone’s own judgement.

Bombing at Sea

Bomber planes usually could carry up to two tonnes of ammunition, which means that on each mission they carried with them bombs in denominations of: either twenty numbers of 50 kg each, or eight numbers of 250 kg each, or four numbers of 500 kg each³. A small anti-aircraft gun of 2 cm could fire

³ Schmidt

about 200 shots per minute. Guns and munitions of up to 20 cm could go on larger naval vessels. During the first two months of war, German pilots were ordered to attack only warships, but the order was soon enlarged to include merchant ships as well. The 'Loewengeschwader' of the Luftwaffe soon claimed to have attacked more than 200 war and merchant ships, sinking 46 of them with a tonnage of 70,000 and severely damaging 76 ships with a tonnage of 300.000⁴.

The veracity of this claim cannot either be confirmed or refuted here. But as the British Admiralty admitted in December 1939, German planes had attacked 35 of its vessels within a period of three days, sinking 7 ships. (NYT, 21



Aerial bomb for merchant ship

December 1939). The total number of bomber attacks against naval and merchant vessels, ports and near coastal installations might amount to many hundreds over the first 3-4 months of war, with thousands of bombs deployed in the North Sea area alone.

Depth Charging of U-boats

How many?

Depth charging submarines during WWII actually meant the hunting down of German U-boats, either by air planes, surface vessels or specially laid mine barrages. When the war started, Germany had only 57 boats ready for service, of which only 23 were fit to operate in the Atlantic. In England it was reported that 15-18 German submarines could have been out at sea on September 1st. (NYT, 4 September 1939). Although the number was small in the beginning, and never more than a dozen boats were in the Atlantic or on missions elsewhere at any time during the first few months, the Royal Navy did not fear anything more than the U-boats. Even with a modest success of sinking more than 100 ships with a tonnage of 100,000, the Allies felt the threat by U-boats seriously and employed all means available at their command to fight this enemy, whether real or imaginary. Consequently thousands of charges could have been deployed day by day.

⁴ Schmidt

⁵ Van Dyke, p.54

⁶ Hackmann, p.303

Care to be taken

The crews needed to be trained and familiarized in such exercises. The following case involving Russian vessels might illustrate such a situation: “(Russian) commanders of transport ships and torpedo boats were so much afraid of being attacked by a Finnish submarine in the Gulf of Finland, that they set off depth charges every 15 minutes or whenever an unconfirmed sighting of a periscope was reported, resulting in a total of 400 depth charges having been dropped by end of operation that day”⁵. Although other commanders might have acted in a more restrained manner, one can easily imagine that a large number of depth charges was being thrown over board every day. During the first 6 months of war, about 4,000 attacks against U-boats are said to have taken place⁶. Every single attack could have meant dozens of depth charges in action.

A seaman’s story?

There were a number of stories circulating about use of depth charges in a variety of ways. Following is one example of such a story:



“It was rough. ...we were investigating a U-boat off Jan Mayen Island. ...the captain gave the order to fire. Eventually the after gun, which was in the gunner’s control, went independent firing and some rounds went away. But for

us, who never had heard a shot fired in anger, the noise was more frightening than the bombs... We carried out asdic sweeps on Sunday 13 October (1939) with the occasional depth-charge attacks, which provided us with plenty of fish, to the chef’s delight. On Tuesday we were supposed to have been successful in destroying the enemy....(In fact there was no ‘kill’).⁷

Some Bombing Events in 1939

The aim of listing of following events is to give a brief illustration of what happened in the first few months of WWII. The military force unleashed was strong enough to change the weather conditions in Northern Europe so much that the coldest winter for 110 years could occur. A considerable number of aerial bombs released over sea, together with other naval and military activities, like patrolling, shelling, anti-aircraft fire, bombing, dropping of depth-charges, and other such activities had turned the sea ‘up-side-down’.

⁷ Thomas, p.21

This could have significantly contributed to the emergence of arctic



conditions. Bomber pilots had reported that they were ‘greeted’ with fierce gunfire salvos when they reached enemy flotilla or a coastline, which made it difficult for them to practice a precise pointed bombing. From the ‘full picture’ only a few events and scenarios can be mentioned here. 4 September 1939: The first RAF raid by

about 30 planes in separate groups targeted a fleet of Nazi naval vessels in the German Bight, (Wilhelmshaven, and Brunsbuettel). One officer reported (NYT, 15 September 1939): “We were near the German coast when half a dozen enemy bombers came out to engage us. A game of hide and seek in the clouds followed.... Conditions grew worse and there was heavy rain for an hour.....(W)e made our land fall accurately and flew up the Elbe estuary until we sighted a number of naval vessels.....The enemy held his fire until we were almost over our targets. Then suddenly he opened every gun he could bring to bear on us. (The pilot described) the anti-air-craft fire ‘terrific’, especially from the larger warships, which seemed to carry seven anti-air-craft guns on either beam”. About seven RAF planes did not return to their home base.

The British air force attacked the German fleet at the North Sea entrance to Kiel Canal (NYT, 5 September 1939); “North Sea - 54 Blenheims and Wellingtons of RAF Bomber Command are deployed without result against German warships sighted in the North Sea”⁸.

8 September 1939: “A concentrated bombing attack on the heavily fortified German island of Sylt.... apparently was made today by, what one observer described, ten to fifteen planes. Anti-aircraft guns boomed and explosions indicated that bombs were being dropped”. (NYT, 9 September 1939).

27 September 1939: “Nazi Planes Raid the British Fleet”; (NYT, 28 September 1939). “Yesterday afternoon in the middle of the North Sea a squadron of British capital ships, together with an aircraft carrier, cruiser and destroyers, were attacked by about twenty German aircraft. No British ship was hit and no British casualties were incurred. One German flying boat was shot down and another is reported to be badly damaged”. (NYT, ditto). “This attack was made by fourteen German land bombers, it is said”. (NYT, 29

⁸ Rohwer
¹¹ Rohwer

⁹ Rohwer

¹⁰ Rohwer

September 1939). “Last Tuesday about twenty German planes attacked a British North Sea Patrol”. (NYT, 8 October 1939).

29 September 1939: “six British planes were reported by the Germans to have attacked a German naval squadron near Helgoland today”. (NYT, 30 September 1939). “Five out of 11 Hampdens (planes) are shot down by German fighters”⁹

5 October 1939: “British submarine’s crew, bombed all day at bottom of the sea”. (NYT, 6 October 1939). “In the first hour six depth charges sounded faintly and in the second hour the explosions, louder and nearer, averaged one every two minutes”,(NYT, ditto).



9 October 1939; “British cruisers hunting submarines in the North Sea (southern coast of Norway) today fought off German bombers, which attacked repeatedly. ... The bombers attacked again and again today, and from the decks of the warships anti-aircraft guns blazed. “ (NYT, 10 October 1939). A German naval flotilla with more than a dozen ships was active; while the British employed 12 Wellington bombers, the Germans sent almost 150 planes to the scene, without registering any success¹⁰. “The entire attack, according to the German version, lasted two hours. The first German air fleet opened a heavy attack from the east and the second followed from the northwest. The number of planes have not been revealed, but the Germans have not denied the British report that more than 100 bombs were dropped, ...”.

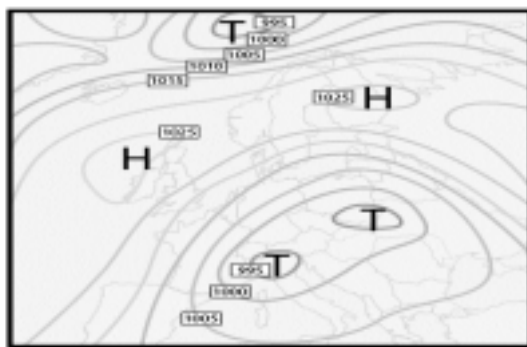
10 October 1939; “Diving from a height of 5,000 feet and driven off by fierce anti-aircraft fire from multiple pompoms of a British cruiser squadron, German bombers battled for more than an hour in the North Sea yesterday until finally repulsed. In the first attack on the British fleet, it is said, the Germans used 500-pound and 1,000-pound bombs.... Lieutenant Frank described the attack, declaring he dropped a 1,000-pound bomb on the carrier”. (NYT, 11 October 1939).

11 October 1939: “Since the war broke out, Sir Kingsley said, the coastal command flew on reconnaissance, anti-submarine and patrol convoys a distance of approximately 1 million miles and provided escort for 100

convoys. Submarines were sighted by planes on seventy-two occasions and thirty-four times the planes were able to attack, he said". (NYT, 11 October 1939).

17 October 1939: "Nazi bomb naval base in Scotland". "About a dozen German planes yesterday, and rained bombs on British naval vessels lying in the Firth of Forth near Rosyth, Scotland. (NYT, 17 October 1939). Three ships are slightly damaged; two bombers are shot down¹¹. "The first two planes were chased away (by British fighters) from 4,000 feet almost to the surface of the water and then out to sea. Ten minutes later several British fighters 'ganged up' against a bomber over Dalkeith and sent it crashing in flames at sea. Another raider was destroyed fifteen minutes later; it also fell into the sea." (NYT, ditto).

18 October 1939: "In a brisk battle in which twelve unidentified warplanes attacked six warships off the Netherlands island Schiermonnikoog, was reported today". "British and German planes battled again over the British naval base at Scapa Flow." (NYT, 19 October 1939). Four German planes attacked ships in Scapa Flow, losing one plane. Training ship *Iron Duke* was damaged in the attack¹².



27 october, 1939

21 October 1939: Nine German bombers bound to attack a British convoy off the Humber estuary are intercepted by fighter planes shooting down four bombers¹³.

5 November 1939: Extract from a British eye witness account: "Our outlook shouted, 'Planes right ahead, Sir; three planes; they are diving, Sir'. Then things happened awfully quickly. Our foremost guns opened fire, with a roar that drowned everything. The muzzles were elevated almost level with the

bridge and yellow flames sprang out, obliterating the shapes of the German machines swooping over the convoy. The sea leapt up in columns where their bombs were dropped.” (NYT, 5 November 1939).

7 November 1939: The first sorties by German torpedo-carrying aircraft were flown against a British destroyer unsuccessfully. The torpedo missed the target¹⁴. 14 November 1939: Nazi planes bomb Shetland Island. (NYT, 14 November 1939).

19 November 1939: A German minesweeper is badly damaged, and a total loss due to depth bombs from another minesweeper off the island Sylt¹⁵.

22 November 1939: Three Royal air force planes send a Dornier (bomber) into the sea before it reaches coast. (NYT, 22 November 1939)

12 December 1939: Eight RAF Whitely bombers attack German seaplane bases at Borkum and Sylt¹⁶

14 December 1939: Twelve RAF bombers attack German warships in Helgoland Bight, losing six¹⁷ “British Bombers and Messerschmitts fight; both sides lose planes in Helgoland battle” (NYT, 15 December 1939). Nazi claim ten planes have been shot down. (NYT, 16 December 1939).



17 December 1939: German bomber planes attack trawlers off the English east coast and sink 10 boats with ca. 3,000 tons¹⁸.

18 December 1939: Driven away from the English coast, two German bombers dived out of the clouds on the 487-ton British motor ship *Serenity*

¹² Rohwer

¹⁵ Rohwer

¹⁸ Rohwer

¹³ Rohwer

¹⁶ Rohwer

¹⁹ Rohwer

¹⁴ Rohwer

¹⁷ Rohwer

today, riddled her decks with machine-gun fire and then dropped 18 bombs until one struck her amidships and sent her to the bottom. (NYT, 18 December 1939).

18 December 1939: Britons see German Raid: “Big bangs shook my house. I saw bursts of fire and clouds of smoke and flames from the direction of the ships three or four miles away. There seemed to be something burning on the water for a minute or two. It looked to me as though something was blown up and went up in flames”. (NYT, 18 December 1939, p.12).

19 December 1939: ‘Air Fleets fight off Helgoland’. ‘34 down, say Nazi’. “The biggest air battle of the war occurred yesterday when British



bombers encountered German pursuit ships over Helgoland Bight.” (NYT, 19 December 1939). The loss is 12 planes out of 24 RAF Wellington bombers deployed¹⁹.

21 December 1939: “German aircrafts have attacked thirty-five vessels, including two neutral ships, in the last three days, the Admiralty announced tonight. Of the ships attacked, one coasting steamer and six fishing trawlers were listed as sunk.” (NYT, 21 December 1939).

Further details: A detailed assessment of events is compiled about the Russian invasion of Finland during December 1939; Russian–Finnish war, 2_41.



Depth charge exploding

Summary

Bombs and depth charges were not only employed at random since September 1, 1939. The weapons had been improved since WWI and their ability to ‘deliver’ precisely had reached new dimensions in warfare. Presumably tens of thousands of massive explosions had mixed-up the sea over a short period of time. The sea reacted swiftly by cooling out too early for the forthcoming winter season, and arctic air could penetrate Northern Europe without facing resistance. Thus it can fairly be concluded that the war at sea had successfully modified the weather. Europe was back in the Ice Age. (A)

Further details: (A) Northern Europe plunged into arctic conditions, 2_11.

Cooling of North Sea – 1939 (2_16)

Introduction

Coming as a surprise!

The North Sea is the principal factor in the climatology of Western Europe. On the one hand, the North Sea is part of the North Atlantic Ocean and is like a big bight. On the other hand, it curves into the landmasses of the European continent. Climatic conditions are therefore transitory. Its climate is neither maritime nor continental. Nevertheless, due to its geographical location, prevailing westerly winds travelling through the hemisphere within a zone of 2,500 kilometres breadth, usually ensure a temperate humid climate.



Suddenly the war winter of 1939/40 was different. The winter turned to arctic conditions from Southern England to Stockholm. That was unexpected and sudden. A.J. Drummond, a scientist from Kew Observatory at Richmond, expressed surprise at this unusual phenomenon in 1943¹ when he wrote: “The present century has been marked by such a wide-spread tendency towards mild winters that the “old-fashioned winters”, of which one has heard so much, seemed to have disappeared for ever. The sudden arrival at the end of 1939 of what was considered to be the beginning of a series of cold winters was therefore all the more surprising. Since the winters of 1878-79, 1879-80 and 1880-81, there have never been such severe winters, three in succession, as those of 1939-40, 1940-41 and 1941-42.”

The North Sea has a significant role only as a transitional area, as long as it is able to sustain the west-wind-drift. (A) Further, the North Sea is a maritime contributor as long as its water masses can contribute to humidity. For this

¹ Drummond

purpose, the sea needs a positive heat budget. If the heat is lost, the maritime role is diminished or gone and the sea turns continental.

Further details: (A) Lost west wind drift, 2_12.

In September 1939 when the German Fuehrer Adolf Hitler dragged the European powers into World War Two (WWII), the North Sea became a battleground. The sea was stirred and mixed from bottom to top at many places, day after day. This is like cooling soup by stirring it with a spoon. Cooling the sea inevitably means inviting continental conditions. Suddenly, arctic weather conditions penetrated into Northern Europe in the winter of 1939/40. Was it surprising?

The theme

The North Sea, being a semi-enclosed sea, may hold the key to understanding reasons for the arctic winter in Northern Europe in 1939/40 and other meteorological changes that started in late 1939. The war machinery that overran Poland in September 1939, the war activities along the French Maginot or German Westwall (A), the churning of Baltic Sea water (B), and the Russian – Finnish war at the Arctic Circle in December 1939 (C), etc may have contributed to returning Europe back into the ‘ice age’. The North Sea’s role in this phenomenon was prominent. It can therefore be fairly concluded that the North Sea, together with the Baltic Sea, played the central role in the emergence of severe winter conditions in Northern Europe in 1939/40, a condition not experienced in more than 100 years.

Further details: (A) Rain-Making, 2_31; (B) Baltic Sea cooling, 2_17; (C) Russian-Finnish war, 2_41.

North Sea’s climatic features



A principal contributor

There are certainly a number of factors relating to the North Sea that usually contribute to prevent Northern Europe from experiencing arctic winter conditions. The following two factors are particularly relevant.

The first factor relates to water conditions that enable Atlantic cyclones to enter the Euro-Asian continent in the middle of Western Europe, via Britain, the North Sea and Central Europe, a corridor called the West-drift by German

weather services in early last century. (A) The second factor, certainly closely related to the first one, is the impact any excessive “stir and shake” of the water body has on heat storage in autumn and subsequently on the conditions of the successive winter. Usually, this is mainly achieved by the wind. A two-day storm can advance or delay the heat status of a season by many days, or for one or two weeks. Can a mighty war machine plough the sea as effectively as the wind? (B)

Further details: (A) Lost west wind drift, 2_12; (B) Naval activities in late 1939, 2_13, 2_14, and 2_15.

Seasonal heat storage

Next to the Atlantic Gulf Current, the North Sea (Baltic Sea is discussed in the next chapter) plays a key role in determining the winter weather conditions in Northern Europe. The reason is simple. As long as these seas are warm, they help sustain the supremacy of maritime weather conditions. If their heat capacity turns negative, their feature turns ‘continental’, giving high air pressure bodies an easy opportunity to reign, i.e. to come with cold and dry air. Once that happens, access of warm Atlantic air is severely hampered or even prevented from moving eastwards freely. This is a particularly serious matter during winter, when the effect of the sun’s radiation to weather processing is comparatively low.

From the above, it is clear that the most critical months are those when the sea experiences greater heat output than heat intake. By the end of August, the North Sea would have accumulated its highest level of heat intake. An important question pertaining to ‘weather’ is how long the sea body is capable of retaining this accumulated heat. This can also be expressed in a more practical way: how long can the sea serve as a central heat reservoir to help provide Northern Europe moderate winters? In fact, the North Sea can and will contribute to this climatic effect, as long as it is not frozen and the surface layer of water has positive temperatures. Even during a longer cold weather period, supply of heat continues, as long as the ‘heat reservoir’ at lower water levels is not exhausted. But while the Atlantic has, during a winter season, an unlimited quantity of retained heat at hand, due to the Gulf Current, the North Sea, which is comparatively small with just an average depth of 60 metres, can store heat during summer at a very limited capacity only. From the peak heat in late August, water loses more heat than it absorbs. At the same time the North Sea holds a considerable quantity of heat to spend. It however reaches its lowest level to spend only in subsequent March, i.e. seven months after the water heat balance turns from receiving to delivering.

Autumn season and the war



While the status of North Sea water is important for the weather in Western Europe throughout the year, three to four months comprising autumn are of considerable importance for processing the build-up of heat for the coming winter months and for sustaining a maritime-based winter. Using this sea area for war activities during this time of the year is hardly a good idea as it may result in a cooler winter. When thousands and thousands of exploding bombs, mines and shells turn the water upside down and when hundreds and hundreds of naval vessels criss-cross the sea day and night ‘stirring’ the sea surface from one to 10 metres or more, increased release of heat is inevitable. Every depth charge could have shaken the sea body down to 50 metres or more. Every sea mine could have ...and so on. Every shell could have; etc; etc.

The rule is the same as applied to a hot soup. The more the soup is ‘stirred’, the quicker it cools down to the level of the surrounding air. Similarly, the stirring of seawater took place everywhere and excessively within the North Sea realms, after major European powers were at war since the 3rd September 1939. Apart from this, any sinking ship or underwater explosion or any other military activities, whatsoever, could have turned a lot of water ‘upside down’.

Further elaboration

This ‘cooling process’ needs further explanation, which will be given in the next section. Thereafter, one section will deal with seawater temperature measurements at the Helgoland observation station in late 1939. These data prove that a ‘stir’ and consequent ‘squeeze-out’ of sea heat took place. Temperatures decreased more rapidly than ever during October and November 1939 since measurements were taken. This had consequences. Along the coast from Jutland to Holland ice formed as early as mid December. A general summary will then highlight the main developments, which took place in the North Sea in late 1939. Finally a number of incidents indicating a ‘breakdown’ in the common temperature structure by the early arrival of winter in the North Sea area are listed in the section ‘Events’.

Temperature Structure in autumn

Sea temperatures vary depending upon their depth and also in accordance with the seasons. The water depth in the North Sea can be roughly divided into two sections.

The southern section comprises a plateau from Dover to the Hanstholm/Jutland – Dogger Bank - Hull/England line that is mostly less than 40 m deep. The northern section is a triangle between Hanstholm – Hull – Shetland Islands with a water depth generally ranging between 60 and 120 m (the deepest place is 263 m), and the submarine valley along the Norwegian coast with depths ranging between 240 to 350 metres, although the Skagerrak, south and east of Kristiansand, is 500 – 700 m deep. Inflow of warm water from the Atlantic Gulf current enters the sea from the north and is influencing the current system from the surface to the bottom in the northern part only. The 40 m deep southern plateau is hardly affected by the northern water, but receives some Atlantic water via the Strait of Dover and freshwater from rivers. Thus the North Sea is rich with different water masses, which vary seasonally and fluctuate annually. As all coastlines are subject to marked tidal forces, considerable water masses actually vary on a daily basis.

In March the annual lowest mean minimum surface temperatures range between 7°C in the northwest (Atlantic water) and 4.5° in the southeast (Dutch coast). The highest mean surface temperatures at the end of August range correspondingly (NW and SE) from 13° to 17.5° in the Helgoland Bight. But these few data reveal very little. What counts climatically during the important autumn period is the whole water column.

During the period December to May the water body has a homogeneous temperature structure (from surface to bottom), with a decrease in temperatures in December (8-9°); January (7.5-6°); February (6.5-5°); March (6-4.5°), April (4.5-6.5°). Water very close to the coastlines has lower temperatures during the winter season.

From May to August a horizontal thermocline builds up but declines during the autumn months.

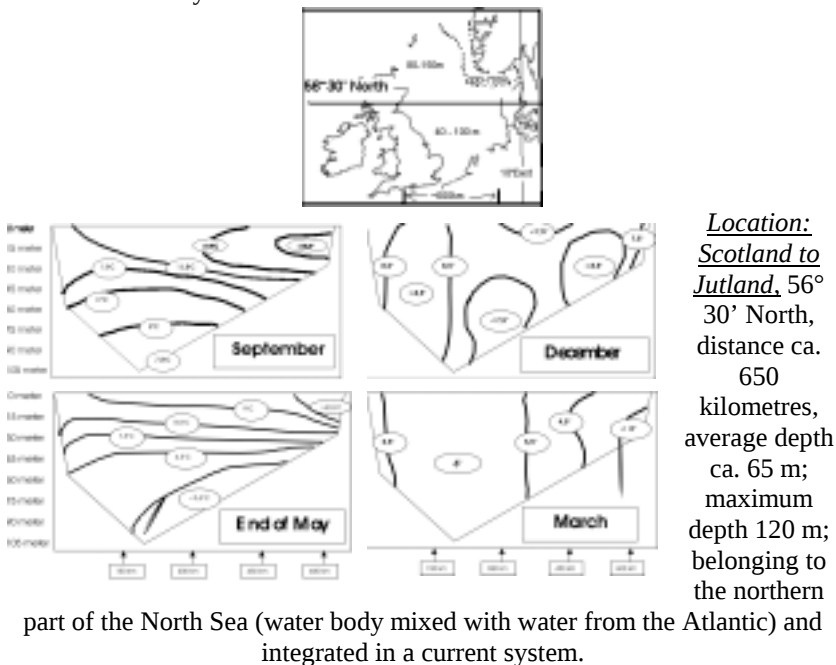
It is worth noting that while the temperature level increases at lower water levels (e.g. 20 m, 40 m) in autumn, it decreases at the bottom (60 m). It is therefore possible that the whole water body might be warmer in September than in August. While the calculation of 'monthly averages' is an approximate figure, it nevertheless gives an indication that the monthly decrease in temperature (or energy release) takes place in small quantities

only, from 11°C in August to 4.5°C in March, i.e. on an average it could be as little as just one degree per month. A more realistic figure would be somewhere between 1°C and 1.5°C.

Conditions from August to November (without coastal waters) are as follows:

	August	September	October	November
Surface	14.5 °C	14 °C	12 °C	10 °C
20 m	13.5 °C	13.5 °C	12 °C	10 °C
40 m	9 °C	9.5 °C	10 °C	9,5 °C
60 m bottom	7 °C	7.5 °C	8 °C	8,5 °C
Sum total	44	44.5	42	42
Monthly av.	11°C	11.1°C	10.5°C	10.5°C

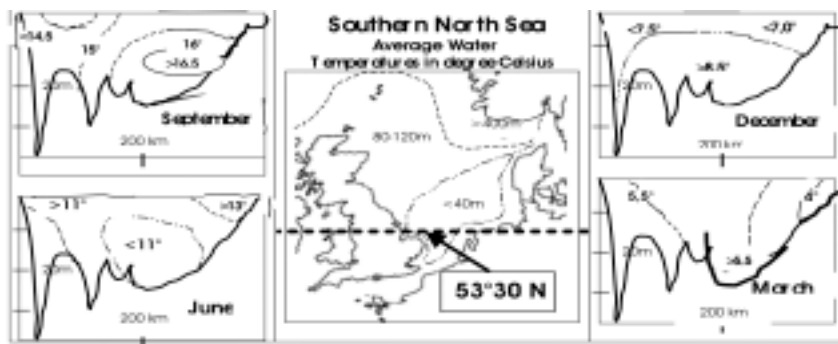
Based on the work of Tomezaqk & Goedecke² data relating to two concerned locations is briefly summarized as follows:



Location: Borkum (Island) – Hull/England, 53° 30' North, distance ca. 400 kilometres,
Average depth ca. 15 m; maximum depth ca 35 m;

² Tomezaqk & Goedecke

Due to the shallowness and tidal forces, temperature structure of the water body is homogeneous (from surface to the bottom) with small variations, as the average temperatures indicate; Dec (8.5°); Jan (6.5-7°); Feb (5.5°); Mar (5°), Apr (6.5°), suggesting that water very close to the coasts has lower temperatures during the winter season. The variations are negligible and can be ignored.



From May to August temperatures increase from 8.5° to 14.5°/17°C and decrease as follows:

Depth	August	September	October	November
Surface, West-East	14.5-17 °C	14-16 °C	12-13.5 °C	09°- (mid) 11.5°-10°
20 m, West-East	14-16 °C	15-16.5 °C	13.5-14 °C	9.5-11 °C

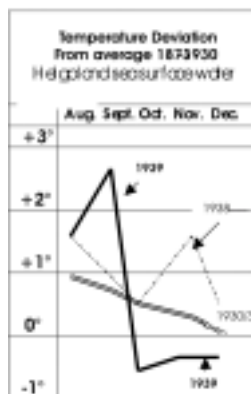
Fairly homogeneous figures for the water body with 15°/16° at peak time and the lowest in March (5°), indicate that the water body experiences an average decrease in temperature of about two degrees per month.

The annual approximate temperature variation data in the three sections of the North Sea is as follows: (Source: Tomezaqk & Goedecke)

	Area in the North Sea		
	Southern section West/East	Middle section West/East	Northern section West/East
Water depth	Temperature °C		
Surface	10/12.5 °C	8/15 °C	6/10 °C
7.5 m	11/13 °C	8/15 °C	5.5/10 °C
20 m	11/13 °C	7/13 °C	5.5/8.5 °C
30 m	11 °C	6.5/12 °C	5/7.5 °C
40 m	-	6/11 °C	4.5/6 °C
60 m	-	4.4 °C	4.5/3.5 °C
80 m	-	3.5°C	4.5/1.5°C
100 m	-	-	4/1.5°C

Water Temperatures recorded at Helgoland Station in autumn 1939

It is well recorded that a positive seawater temperature series in the Helgoland Bight from 1930-39 at the Helgoland station with WWII commencing suddenly came to an end. Goedecke dates this end at 1940-1942³. Nearby light vessel “Elbe 4” on the mouth of the river Elbe records the annual anomalies as: 1939 (+0.9); 1940 (-0.7); 1941 (-0.7); and 1942 (-0.2). At both stations seawater temperatures increased again after 1942. Goedecke attributed this increase in temperatures until 1940 and after 1942 to “the secular climatic changes in the Northern Hemisphere”⁴, resulting “primarily from the warming of the polar and sub polar atmosphere”⁵.



This paper’s next step is to look in detail at the figures available for 1939, showing an average annual seawater temperature increase of 0.9°C. The starting line will be August 1939 to prove that the war at sea, during its initial months, i.e. September to December 1939 made its clear contribution in ushering in the arctic winter of 1939/40 in Europe.

Figures from Helgoland station showing deviations from average temperatures during the autumn season of 1939:

Average temperature 1901-30	August 16.34°	September 15.60°	October 13.15°	Nov. 9.68°	Dec. 6.48°
Deviation: 1930-37	+1.05	+0.85	+0.55	+0.3	+0.5
Deviation: 1938	+1.6	+1.0	+0.6	+1.7	+0.6
Deviation: 1939	+1.7	+2.6	-0.6	-0.4	-0.3

Source: Goedecke, Verhalten, p.7

Deviations of seawater temperatures from the mean (1901-30) at Helgoland Station in early 1940 are:

	January	February	March	April
Diff.: 1940	-1.6	-3.5	-3.0	-2.3

Source: Goedecke, Verhalten; p.7

Even if one is fully aware that the water masses of the German Bight (Helgoland Station) do not represent the North Sea as a whole, the

³ Goedecke, Ergebnisse ⁴ Goedecke, Ergebnisse ⁵ Goecke, Ververhalten p.28

differences are remarkable. The first hard fact is that August 1939 figures of water conditions had been in the normal range. A high figure for a corresponding period as in September 1939 had been recorded only once before, i.e. in September 1875. The September 1939 figure is most likely so high because of extraordinary naval ship movements and military activities that took place, 'shovelling' lower and warmer water up to the surface. Once warmer water reached the surface, evaporation increased and subsequently seawater cooled more quickly.

This becomes evident in two ways; firstly by the difference in temperature between September and October, and secondly by the high deviation in temperature from the previous decade by one degree in each of the months of October, November and December 1939, showing a very spontaneous and significant deviation from the sea climatology of the Helgoland Bight.

If one can rely on the figures given by Goedecke, it can be fairly assumed that military activities were a key contributor in the arrival of the arctic winter of 1939/40. 'Normal' monthly seawater temperature decrease recorded at Helgoland Station is 2.5°C from September to October, with a minor deviation ($<0.4^{\circ}\text{C}$) over the decade since 1930. In 1939 water temperature decreased within a period of one month from September-October by 5.7°C (normal 2.5°C; plus 3.2°C in 1939). Therefore this big drop requires an explanation. Further, the negative figures observed for the period October – December would certainly have contributed to the surprising arrival of the cold winter. These events of 'temperature changes' at a place where the German navy was very active, by laying thousands of mines in close by areas and the bombardment by British aeroplanes cannot be ignored by climate watchers. Links of these events to ensuing winter conditions are quite obvious.

Early, severe and long lasting icing conditions

Icing along the Danish, German and Dutch coasts started early (see below: Events), and sea ice conditions lasted longer than in dozens of previous years. On the other hand, the main features of the 1939/40 icing are not 'completely' out of question. For example, in December 1938, ice formation started early due to a sudden cold spell, but it lasted only for two to three weeks. The winter of 1938/39 is listed as a quite moderate one, in fact, the warmest for decades. Also the post war winter of 1946/47 could, in some respects, be regarded as an even icier winter than the first war winter of 1939-40, at least with regard to the North Sea, but the winter of 1946/47 was of a totally different nature than the winter of 1939/40. (A)

Further details: (A) Late winter 1946-47, 4_21.

The importance of the winter of 1939/40 as proof of the impact created by war at sea on climatic changes since 1939 remains valid in every respect. Circumstantial evidences throwing light to the war winter of 1939/40 are manifold and include following facts concerning sea ice:

- seawater temperature data at Helgoland in autumn of 1939;
- suddenness with which icing started;
- early start and longer stay of ice;
- severity of icing;
- long duration of the icy period caused by two cold waves, one in January and another in February 1940.

Changed factors

Interchange air - water

During the first four months of war no quadrant of the North Sea would have seen the same war activities as any other location might have. Considering the very basic factors, it seems reasonable to concentrate on the southern plateau section, south of the line Hanstholm/Jutland – Dogger Bank – Hull/England and the section north of this line. The southern part with its low depth and nearly homogeneous water body condition round the year, saw, by far the most aggressive military activities during the early days of the war, such as 20-50,000 mines along the “Westwall” in the middle of the North Sea over a length of 1,000 kms, 10,000 mines along the Dutch and English coast, hundreds of naval ship movements, depth charging and bombing, etc. every day. (A) However, the northern part saw certainly less activity, but due to the temperature structure depending on water depths, the water body would often react quite differently than in the southern part section and with a long-term effect.

Further details: (A) Sea mines, 2_14; and Depth charges, 2_15.

A few words concerning the dynamics of seawater evaporation and seawater cooling: Water vapour escapes into the atmosphere only from water surfaces. The intensity of this process depends on the temperature difference between the media, and also whether a certain amount of water vapour is in equilibrium with the water surface. If it is less, seawater will vaporise; if it is higher, the vapour in the air will condense and transform into clouds, rain, fog etc. In each system (water – atmosphere) the level of temperature is important. A rise in air temperature from 0°C to 10°C doubles the amount of water in the atmosphere at equilibrium.

Evaporation cools a water surface by removing heat from it. As water cools, the equilibrium decreases and the evaporation rate will decrease. Cold and salty water increases vertical convection (water movements by sinking); warm and low salty water tends to sink less.

However, in this investigation only two rules will be considered:

The warmer the water, the more evaporation;
The more evaporation, the more the water cools.

For the atmosphere this means: Adding water vapour to the atmosphere makes it less dense and causes vertical air movements. In the case of the North Sea, when air rises from a surface water layer, air thus lifted upwards must be replaced by air that is surrounding the location of evaporation, whereby dry air, presumably continental air, may try hardest to fill this space. Back in 1939 the German weather analyst wondered, when the usual wind from South-West turned to North-East. (A)

Further details: (A) Lost west wind drift, 2_12, see: “End of October 1939”, or Seewarte, 02 November 1939.

Climatic conditions in Northern Europe had been regarded as ‘normal’ during the first eight months of 1939 until the end of August. Based on this assumption, the chain of causes in forcing a deviation in mean conditions during the winter of 1939/40 could have worked as follows:

- stirring of sea waters increased evaporation;
- this blocked the west-wind, caused continental air to move in (N-E winds) and increase the barrier;
- colder continental wind and high evaporation rate cooled seawater;
- while the cooling effect was not very pronounced early, due to the fact that ‘stirring’ of the sea continued bringing warmer water to the surface thus delaying the ‘typical’ winter effect (e.g. icing);
- this is clearly reflected by strong temperature deviation from January – April 1940, and particularly by a long duration of the ice period (see below: Events).

Southern North Sea: Due to low water depth (max 40 m) and tidal forces, the ‘mixing’, whether by natural dynamics or military activities, will occur fairly quickly throughout the whole water body. Correspondingly, the chain reaction affecting evaporation, change of wind direction and cooling, etc will set in motion:

- if, at the peak time of high surface temperature, this water is mixed with colder water at deeper levels, the total heat capacity will rise and the evaporation process will be reduced at the surface for some time;

- if the stirring process continues or even increases, warm water from lower levels is exposed to the evaporation process at a higher frequency, thus accelerating the cooling of the surface and forcing wind to replace rising vapour;
- the emergence of the first visible sign of cooled down seawater (icing) can be delayed by the continuation of the ‘mixing’ of water.

All these criteria are clearly reflected in the sea surface data from Helgoland for the winter period of 1939/40. These main results can be fully applied for all of the southern part of the North Sea, south of the Hanstholm/Jutland – Dogger Bank - Hull/England line, even taking into account, that the Helgoland Bight particularly had been highly exposed to naval activities.

Northern North Sea: The forced ‘stirring and mixing’ situation of the water body in the northern part is much more diverse and intense than in the southern part during autumn. A naval activity that may force the cooling of the sea surface layer in September may, by similar activity increase evaporation in December, or may be doing both actions at the same time. On the other hand, a stirring and mixing within the upper water layer down to 10 or 20 metres in early autumn will, just as it does in the southern section, actively support an accelerated evaporation process in September and October. But speaking in general terms, a military activity-forced mixing in autumn will move warm water to a greater depth, thereby extending the retention of the amount of stored heat by weeks or even months. It should not be regarded as too big a surprise, if the northern section of the North Sea may have even contributed with a release of more heat into the air during the later part of the winter of 1939/40 than during other years.

Heat matters

Since the day the Second World War had started naval activities moved and turned the water in the North Sea at surface and lower levels at 5, 10, 20 or 30 metres or deeper on a scale that was possibly dozens of times higher than any comparable other external activity over a similar time period before. Presumably only World War One could be named in comparison. The combatants arrived on the scene when the volume of heat from the sun had reached its annual peak. Impacts on temperatures and icing are listed in the last section: ‘Events’ (see below). The following circumstantial evidences help conclude with a high degree of certainty that the North Sea contributed to the arctic war winter of 1939/40.

Meteorological ‘West Wall’– Wind Drift blocked

Excessive evaporation from the first day of September until November 1939 could be evidenced by a decrease in water temperature at Helgoland Station, Rising air (vapour) instead of attracting Atlantic cyclones to move into the North Sea area to travel east, in fact assisted in blocking their movement. Presumably, this aspect alone would not have changed the situation very much. But the rising air certainly forced inflow of continental air from East and North. This air, flowing almost in the opposite direction to the West drift, necessarily prevented or reduced the movement of Atlantic cyclone systems to travel on common routes. Daily weather analysis of the Seewarte wondered a number of times where the West Drift had gone. Excessive heat release as illustrated in previous paragraphs was the most likely cause for blocking Atlantic cyclones from reaching and passing Western Europe as was usually expected. In December, high pressure took full control in Europe and the North Sea, leaving cyclones the only opportunity to storm east either via the Barents Sea, or crash through the Iberian Peninsula into the Mediterranean Sea. (A) Others turned north and passed the battlefields in the Arctic Circle in the Russian – Finnish war. (B)

Further details: (A) Violent weather, 2_52; (B) Russian-Finnish war (2_41.

More Evaporation – more wind, rain, cooling

Water, among all solids and liquids, has the highest heat capacity except liquid ammonia. If water within a water body remained stationary and did not move (which is what it does abundantly and often forcefully for a number of



reasons), the upper most water surface layer would, to a very high percentage, almost stop the transfer of any heat from a water body to the atmosphere.

However, temperature and salt are the biggest internal dynamic factors and they make the water move permanently. The question as to how much the ocean can transfer heat to the surface depends on how warm the surface water is relative to atmospheric air. Of no lesser importance is the question, as to how quickly

and by what quantities cooled-down surface water is replaced by warmer water from sub-surface level. Atmospheric factors responsible for exposing quickly new water masses at the sea surface are wind, cyclones and hurricanes. Another ‘effective’ way to replace surface water is to stir the water body itself. Naval activities are just doing this.

On the basis of sea surface temperature record at Helgoland Station and subsequent air temperature, developments provide strong indication that the evaporation rate was high. This is confirmed by the following impacts observed:

More wind: As the rate of evaporation over the North Sea has not been measured and recorded, it seems there is little chance to prove that more vapour moved upwards during autumn 1939 than usual. What can be proved is that the direction of the inflow of wind had changed from the usually most prevailing SW winds, to winds from the N to E, predominantly from the East. At Kew Observatory (London) general wind direction recorded was north-easterly only three times during 155 winter years; i.e. in 1814, 1841 and 1940⁶. This continental wind could have significantly contributed to the following phenomena of 1939: ‘The Western Front rain’ (next paragraph).

More rain: One of the most immediate indicators of evaporation is the excessive rain in an area stretching from Southern England to Saxony, Silesia and Switzerland. Southern Baltic Sea together with Poland and Northern Germany were clearly separated from the generally wet weather conditions only three to four hundred kilometres further south. A demonstration of the dominant weather situation occurred in late October, when a rain section (supplied from Libya) south of the line Middle Germany, Hungary and Rumania was completely separated from the rain section at Hamburg – Southern Baltic⁷. Plentiful rain from England to Silesia/Germany and to Switzerland may have been caused by military activities as follows:

A north-easterly wind pushes humid air (partly generated by naval war in North Sea and Baltic Sea) southwards, while the coldness of the pushing air and abundant supply of condensation nuclei, by shelling, bombing etc., intensify cloud formation and condensation further, thus forcing and sustaining rain over a longer period of time. (A)

Further details: (A) Rain-Making, 2_ 31.

More cooling: Further, cooling observed from December 1939 onwards can be linked to war activities in two ways. The most immediate effect, as has been explained (above), is the direct result from any excessive evaporation

⁶ Drummond

⁷ Seewarte

process. The second (at least for the establishment of global conditions in the first war winter) is the deprivation of the Northern atmosphere of its usual amount of water masses, circulating the globe as humidity. The less moist air is circulating the globe south of the Arctic, the more easily cold polar air can travel south. A good piece of evidence is the record lack of rain in the USA from October – December 1939 (A), followed by a colder than average January 1940, a long period of low water temperatures in the North Sea from October-March (see above) and the ‘sudden’ fall of air temperatures to record low in Northern Europe.

Climatic conditions in the North Sea in autumn 1939, together with those of the Baltic Sea (B), played a key contributory role in sustaining the coldest winter in Northern Europe for more than 100 years.

Further details: (A) USA dried out, 2_32; (B) Baltic Sea cooling, 2_17.

Events: Temperatures or Serious Icing in the North Sea Winter of 1939/40

The following list does not give a full picture of events but only points to some major events, places and impacts reported.

11 December 1939; Helgoland reported frost on December 11 and December 13-19 (from December 14-18 mean temperature of -1,6°C; December 15, mean temp. -3,6°C; lowest December 16, – 4,5°C; and frost from December 26-31⁸.

16 December 1939; Ice on river Elbe, (e.g. Glückstadt, Hamburg), remained continuously for more than 90 days until mid March, 1940⁹.

17 December 1939; Tönning (near Husum) reported first ice, which remained for 100 days¹⁰. Note: Before icing commences along the German North Sea coast, the air temperature needs to be below zero for about 4 to 5 days¹¹.

17-21 December 1939; Almost all observation stations along the German coast from Nordstrand (island south of Sylt and Amrum) to Borkum report the emergence of sea ice, its stay in the south ca. for 60 to 70 days, and further north of Cuxhaven for 70 to 102 days¹². North of Husum (Amrum, Sylt) ice remained from early January for approx. 60 days.

⁸ Witterungsbericht

⁹ DHI_Eisbeobachtungen

¹⁰ DHI-Eisbeobachtungen

¹¹ Nusser, Gebiete

29-30 December 1939; During the night of 29/30 a strong southwest storm swept through Helgoland Bight (Helgoland up to 11 Beaufort)¹³. At the same time in far East Germany (East Prussia) very cold air of more than -20°C, had been blowing from the North and pushing further south¹⁴.

1 January 1940; Monthly mean air temperatures for January 1940 for Westerland, Helgoland, Emden¹⁵ :

Location	Month	Mean air temp.	Deviation from average	Lowest/day
Westerland	January 1940	- 4.2°C	- 5.3°C	-13.5°C/Jan.19
Helgoland	January 1940	- 3.2°C	- 5.1°C	-12.4°C/Jan.31
Emden	January 1940	- 7.0°C	- 8.1°C	-17.9°C/Jan.10

2 January 1940; Esbjerg – soft or new ice, navigation not hindered, Danish light buoys were withdrawn over the next 10 days¹⁶.

6 January 1940; Drift ice in the East Scheldt. Ameland temporarily cut off from the mainland by ice. river Maas is frozen over from Woudrichem to Heusden¹⁷.

14 January 1940; Drift ice on river Scheldt reported to have torn buoys from their mooring¹⁸. Frankcom made the following comment just a few days later: “in these nine days conditions have deteriorated very rapidly and one sees the first real indication of somewhat abnormal conditions, most particular is freezing of rivers Scheldt and Maas”.

17 January 1940; Ice reported in the North Sea off Jutland for the first time in many years, up to 2 miles from the coast. Fjord in Jutland frozen over. Ice three metres thick reported from western end of Limfjord. Minus 23° F reported during the night in Denmark¹⁹

20 January 1940; Difficulties due to ice reported in the river Scheldt²⁰.

21 January 1940; Heavy ice drift reported on the west Scheldt ²¹.

¹² DHI-Eisbeobachtungen ¹³ Seewart ¹⁴Witterungsberichte
¹⁵ Witterungsberichte ¹⁶ Frankcom ¹⁷Frankcom
¹⁸Frankcom ¹⁹ Frankcom ²⁰ Frankcom ²¹ Frankcom

23 January 1940; More difficulties due to ice reported on river Scheldt. Many small vessels bound for Antwerp were put into Flushing because of ice. Navigation to Brussels was closed by ice. Fast ice reported at Lobith, on the river Rhine²². Frankcom concludes in his report dated January 23, 1940, noting: "...the spread of ice out into the North Sea itself is a definite indication of unusually severe weather. It is particularly unusual for shipping to be held up in the river Scheldt."²³



27 January 1940; Helgoland had ice for 10 days between January 27 and February 23²⁴; duration of ice formation in Helgoland is 11 days²⁵.

28 January 1940; In the close vicinity of London river Thames had been frozen for the first time since 1814. (Neue Zürcher Zeitung, 29 January 1940).

1 February 1940; Given below are monthly mean air temperatures for February 1940 in respect of Westerland, Helgoland and Emden²⁶:

Location	Month	Mean air temp.	Deviation from average	Lowest/day
Westerland	Feb. 1940	- 6.1°C	- 6.9°C	-13.5°C/Jan.19
Helgoland	Feb. 1940	- 4.1°C	- 5.7°C	-12.4°C/Jan.31
Emden	Feb. 1940	- 3.7°C	- 5.3°C	-17.9°C/Jan.10

Remark: It should be noted that January was colder in Emden than in Westerland, which ranks first in February, a fact that could support the thesis that war activities in the northern section of the North Sea, delayed cooling of the sea (see previous chapter).

From February until March 1940 general winter conditions remained very severe. While investigating causes for the harsh winter, weather conditions observed in the month of February are considered important as a second cold spell pushed the winter to record low level. (A)

Further details: (A) Winter 1939/40, 2_11.

²² Frankcom

²³ Frankcom

²⁴ DHI - Eisbeobachtungen

²⁵ Nusser, Gebiete

²⁶ Witterungsberichte

Baltic Sea paved way for extreme winter (2_17)

Preamble

The Baltic Sea, in terms of size, is a mere ‘drop’ in the world’s oceans but due to its strategic location and specific features, acts as a ‘significant’ force affecting the weather of those countries surrounding it. It is an excellent location to study climatology as mentioned by the Russian scientist Kuznetzow-Ugamski in 1933: “The study of climatology especially relates to study atmospheric processes developed near the surface of the earth-crust. It is not only an atmospheric process as such, but a very peculiar climatic process, which is the result of thermo-dynamical fluctuations of the same atmosphere, influenced by the ‘underlying surface’ of the earth. The same atmospheric (synoptic) process, in diverse localities may have several local peculiarities, more or less specific to every one of given regions, with regard to form of relief, width and distribution of water-basins, and characteristics of vegetation etc.”¹

Introduction

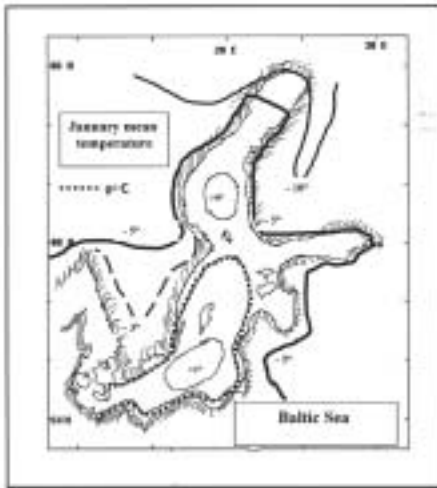
In this study the Baltic Sea is given the same climatic importance as given to the North Sea, insofar as the former plays a key role in determining winter conditions in Northern Europe. Therefore full reference is made to the relevant paper. (A) Further, the Baltic Sea has features that are very different from those of the North Sea. Some of these most significant aspects, relevant to the situation in the autumn of 1939, will be briefly discussed in the next section. Thereafter, main military activities and meteorological events relevant to the issue, will be mentioned and analysed, even though this is not always done in a chronological order. The ‘List of events from September 1939 – March 1940’ given at the end of this section refers to most relevant or interesting events only.

To aid understanding, it seems reasonable to give some early attention to the historical list below, the special study on the Finland-Russian war in December (B) and other papers on naval activities in 1939. (C) A similar approach is adopted with regard to ice conditions in the Baltic. While some general situations of ice cover in the winter of 1939/40 will be discussed here, icing of the Baltic Sea during the three winters from 1939 to 1942 will be dealt with elsewhere. (Chapter D) After all, icing of the Baltic Sea during the winter of 1939/40 was the severest in many decades and together with following winters constitutes core evidence to suggest that the war machinery certainly caused climatic changes observed since the start of WWII.

Further details: (A) North Sea cooling, 2_16; (B) Russian - Finnish war, 2_41; (C) War at sea 1939, 2_13, Sea mines, 2_14, Bombs and depth charges, 2_15; (D) Winter 1940/41, 3_11, and Three years package, 3_31.

¹ Blüthgen, Geo

Baltic Sea – Physical features and Winter Climate



The total area of the Baltic Sea is 400,000 square kilometres with an average depth of 55 m including the Gulf of Bothnia (55-294 m) and the Gulf of Finland (lower than 30 m). The southern Baltic, except Gdynia Bight (114 m), is less than 50 m deep. Climatically the most important feature of this sea is a high mountain ridge from north to south Norway with a height of 2,500 m. Behind this barrier, continental and polar air have much easier access than in areas where Atlantic air travels east at a low elevation level. This

frequently guarantees mild summers to Baltic countries by significantly delaying the arrival of continental winter conditions. The mountain ridge also prevents heavy winter conditions by preventing the invasion of Arctic air masses with very high surface fluxes of sensitive heat and moisture that can reach conditions common to those, which exist in the Arctic². There is hardly any other sea in the northern hemisphere, which can convincingly demonstrate the importance of heat storage and release process as the Baltic Sea. Actually, very cold conditions cannot prevail on sea and in nearby coastal areas over a longer period as long as the sea is open and not iced. Icing is a very critical point in the regional climatology. Every sea area covered with ice loses ten times less energy to the atmosphere than an open sea area³. The importance of heat flux can be clearly demonstrated by temperature data records that show that winter average at the seaside is considerably higher than further inland, whereby the temperature sometimes decreases in great leaps, i.e. by 1°C per 50 km or more, depending upon the distance from the coast.

From mid September to the end of February, when the air is colder than the seawater, the water temperature decreases between 13°C and 15°C, which is significantly more than that of the North Sea (9.5-11.5°C). This actually means that the surface temperatures with an average ranging between 0°C (north) and 3°C (south) in January quickly come close to zero. Heat stored at lower levels exists but is negligible. Deeper waters, 80 metres and below, have just 4-5°C, while the water column above varies according to the

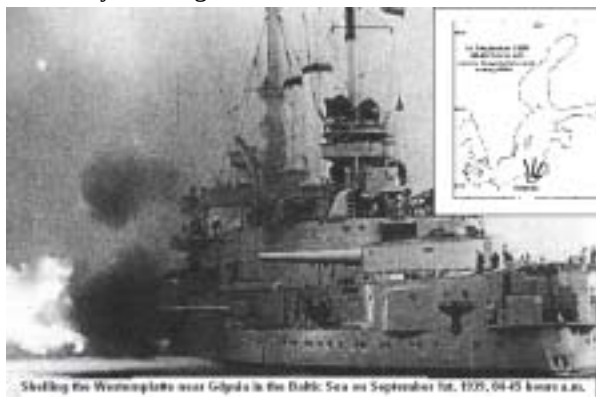
seasons⁴. These temperature changes through the seasons are effective from the surface to about 80 m depths. While surface water reaches their peak temperature by the end of August, lower levels may reach its peak later on (e.g. 40 m, with 10°C in late October). All activities that took place at sea in September thus could have forced considerable warm water masses to greater depths, which may have delayed the icing process by days or even weeks.

German navy starts war

The German Navy assembled within sight of Gdynia at dawn on September 1, 1939 with a fleet of about 40 ships. At 4:45 a.m. battleship *Schleswig-Holstein* started shelling the Westerplatte with big calibre guns.

After 13 days of pounding shells from sea to land and coastal batteries shooting at the armada of naval ships out in the Baltic, Gdynia fell. Thereafter, other positions along the Polish coast were shelled fiercely from the seasmaking their defences in vain. With the shelling of Hela (Gdanska Bight) by two German battleships from September 25-27, the last Polish coastal defence position was silenced⁵. Within four weeks, the Germans had brought the entire Southern Baltic coast under their sole control. How much of the several thousands of tons of ammunition fired exploded on or under the sea surface is difficult to assess. Substantial areas of the sea affected were certainly stirred and mixed heavily.

Heavy exchange of shelling for almost four weeks at a sea area with depths down to 114 metres could have severely altered temperature compositions, normally ranging from 17° C at surface, to 4°C at bottom at the end of August (at 20 m ~14°C; at 30 m ~8°C, at 40 m ~6°C). It would be a miracle if heavy shelling had not forced warm water into much deeper water layers



and colder water to the upper layers. Under such circumstances it seems totally unavoidable that since the start of war considerable parts of the south-eastern Baltic must have had much lower water temperatures than usual. The following evidences suggest

² Raschke

³ Finnish Institute

⁴ Magaard et al, p. 51.

⁵ Rohwer

this: (1) freezing temperature at Rügenwalde (about 150 km west of Gdynia) on September 26, and on October 4, 1939 at Königsberg/Kaliningrad (see below: Events), (2) icing of the sea at Gdanska Bight started by mid December, which although early, does not indicate immediately any extreme situation. This could have been due to the fact that masses of surface water, forced into greater depths in September, may have returned back to surface at a later time. In this respect it should be noted that icing process started earlier in North Germany (see below: Events, Dec. 18 – 28) and along the southern Baltic coast (early Jan. 40), while the Gulf of Finland was still open as far as Pellinki, until January 17, 1940, when icing started very rapidly⁶.

All waters along the Southern Baltic coast were put under severe stress from September 1, 1939 onwards. The German Navy was navigating the waters extensively. They used these waters to train tens of thousands of their naval personnel, including firing by guns into designated sea areas. Many mine fields had been laid to west of the island of Rügen and Trelleborg. The Danish government had also arranged for laying of mine fields in the three navigation channels of Copenhagen. (NYT, 03 September, 1939). Even though water is shallower west of Gdanska Bight, the war could have had a considerable impact on the southern section of the Baltic Sea as explained.

An indication of the impact on weather exerted by all these activities is the early icing in the western Baltic (since December 18) and its lasting longer than usual, until the end of March, 1940. In addition, water modification in the Southern Baltic would certainly have contributed to weather changes in the same way as in the North Sea (A), particularly in supporting a ‘corridor’ of increased continental air pressure (B), which culminated in a lasting independent cold air plug close to the southern Baltic Sea for six weeks; see below: Events, 15 January, 1940⁷.

Further details: (A) North Sea cooling, 2_16; (B) Lost West Wind Drift, 2_12.

General developments until the end of the year 1939

The northern Baltic Sea had not seen as many war activities as mentioned in the previous section or any obviously erratic or unusual weather behaviour until Russia invaded Finland on November 30, 1939. Traffic at sea was certainly several times higher than in previous years. Besides, Swedes laid mines and the Navy of the Soviet Union was active in Baltic countries. A number of cyclones entered the sea from the North, while some of those, which had originated in the Adriatic Sea, were blocked south of the Polish border. A ‘clash’ between a military and meteorological chain of events

⁶ Palosuo, p.92 ⁷ Palosuo

erupted with the war in Finland. The first big ‘clash’ should be attributed to the ‘Rain Making’ in Western Europe (A), as ‘closing’ of the west drift can hardly be ignored as a very early contribution either. (B)

Further details: (A) Rain-Making, 2_31; (B) Lost West Wind Drift, 2_12

Soviet-Finnish War - December 1939

Strange coincidence

Extraordinary developments in the high North during December 1939 have been studied elsewhere. (A) How many unusual meteorological events are necessary as sufficient proof that war changed weather? Here are some of the events: On November 30, 1939 the Red Army attacked Finland at a number of locations along a 1,000 km long border, running north–south, from the Barents Sea to a point east of Vyborg. Red Army strengths was 300.000 men and more. On December 1, the Red Army bombed cities; on December 2, snow started falling; on December 4, “blinding snowstorms” affected fighting; and the first cold period lasted from December 7-15. When weather had cleared for the first time after two weeks, this improvement in weather was immediately utilised for intensive bombing and fighting missions on 19th December. The second extreme cold wave entered the scene on the next day. “The Russian drive was stalled in the far north by blizzards and temperatures 25 degrees below zero (minus 31° C). (NYT, 21 December 1939). This was only the beginning and it became much worse. Unbelievably extreme weather conditions were reported. (A) However, as much as there is no political excuse for the invasion of Finland, it would be wrong to call the Russian decision to invade Finland in early December ill judged. Actually, according to all indications available at that time, there was nothing to suggest that such extreme weather would happen. Neither was there any precedent indicating that it could happen so suddenly and so early. Normally, the average temperature in December in Murmansk is about -10°C; and average low temperature there in December is -13°C; which is still much warmer than -35°C reported in December 1939. (NYT, 25 December 1939).

A selection of numerous naval and military activities in the northern Baltic Sea that presumably played a major role in the relatively late icing of the Gulf of Finland is listed in the relevant paper (A), while the main conditions in regard to icing in the winter of 1939/40 are dealt with in the next paragraph.

Further details: (A) Russian-Finnish wars (2_41).

Ice condition in the winter of 1939/40

The Baltic Sea had not been covered with as much ice since 1883. The coverage 1939/40 was tremendous exceptional. Ice did not start retreating

until around March 8, 1940. The conditions for building up of ice differed in three ways from the average of previous years. 1) Even though ice started to form in the very North very early, solid ice developed at the usual time; 2) Ice formation started at first in the southern Baltic Sea, and 3) Icing in the Gulf of Finland followed rapidly with a cold wave of 14 –24 January 1940⁸. In the South, at the Greifswald Bodden (an open bight SE of the island of Rügen), icing started on December 18, 1939, solid ice remained in place without any interruption until April 4, 1940, and last ice disappeared on April 11, 1940⁹.

In Hanko/Finland (at the west entrance to the Gulf of Finland), icing started on December 27, 1939; solid ice formed on January 4, 1940; end of ice came on May 7, 1940.; at almost the same time as Helsinki¹⁰. However, on January 15, 1940 the Gulf of Finland was still open as far East as the median of Pellinki. In the Gulf of Bothnia, the sea was also open in most parts. Ice then formed rapidly¹¹. Just to remind. Although the Gulf of Bothnia is far in the North it is with over 200 metres – in the Baltic Sea area -the deepest water, holding considerable heat for considerable time even in cold winters. An ‘ice-bridge’ between Turku and the island of Åland formed on January 6/7, 1940, which is about 2 ½ weeks earlier than usual¹².

There is no other valid explanation for any deviation in weather from earlier averages than the war activities at sea. Most of the factors relevant to the Baltic Sea are the long open sea areas in the Gulf of Finland, a clear

indication that, due to military activities a high mixing of water took place preventing the formation of ice. On the other hand, early formation of the ‘ice bridge’ showed that water of that area had already cooled enough to freeze, in this case, more than two weeks earlier than a place like Hanko, less than 100 km away.

Subsequent winters and summary

Being land locked and located in the far north, the Baltic Sea is particularly sensitive to water heat. This became very obvious during the next winter of 1940/41 when, during initial months of the war, the sea was not made a major battle ground. Winter cold centre shifted ‘a little bit’ further west to the Skagerrak and South Norway region.



⁸ Jurva, p.22

¹¹ Palosuo

⁹ Blüthgen, Eis, p.143.

¹² Jurva

¹⁰ Jurva, p.48

(A) The Baltic Sea's climatic sensitivity in the events of 'turning the water about', became particularly obvious in the war winter of 1941/42, when the German Navy battled with the Russian Baltic Fleet for supremacy over the sea from the summer of 1941 until the winter of 1941/42. (B) It was colder than even during the Little Ice Age. (C) The Baltic Sea was used as a great style field for the experiment on anthropogenic climatic forcing. It proved to work after four months of naval activities in 1939.

Further details: (A) Arctic by occupation, 3_11; (B) Baltic battle field, 3_21; (C) Stockholm's record freeze, 3_23.

List of events from September 1939 – March 1940



24 September 1939; Snowfall in Baltic countries. A low pressure (1,000mb) originated in the western part of the Gulf of Finland, with wind force 6-8 Beaufort near Sundsvall and Åland Island¹³.

26 September 1939; Temperatures: at Rügenwalde (small city at the Baltic coast, 150 km west of Gdynia) on 26th September: -0.4°C; on 27th +1.5°C; in Königsberg/Kaliningrad 25-27th, (+2.5° C to +1.6°C). Putbus (Rügen), 24-29th (+5.2°C to + 3.8°C)¹⁴.

27 September 1939; Hamburg -2.5°C¹⁵.

11 October 1939; A high pressure over Finland brings cold air of arctic origin to East of Germany, Königsberg (Kaliningrad) - 3°C average. Within the range of this cold air first light snow occurred in the Gdynia Bight. Actually, Königsberg had already experienced -1°C on 04 Oct.¹⁶.

¹³ Seewarte

¹⁶ Witterungsbericht

¹⁴ Witterungsbericht

¹⁷ Seewarte

¹⁵ Seewarte

Mid-October 1939: Some lakes and rivers froze in Northern and the middle of Norrland/Sweden, as well as in NW of Svealand (Middle Sweden), which usually happens only towards the end of the month¹⁷.

01 November 1939; Together with the first snow showers in the eastern Baltic, cold air had been carried as far as the line Bohemia – Helgoland Bight¹⁸.

19 November 1939; Danish Light vessel Anholt Knob (Kattegat) reported snow fall¹⁹.

26 November 1939; Danish Light vessel Anholt Knob (Kattegat) reported snow fall²⁰.

01 December 1939; First appearance of ice in the Baltic was indicated by reported withdrawal of Helsinki Light Vessel from its station²¹.

04 December 1939; Navigation closed at Kotka (Gulf of Finland)²².

07 – 15 December; Light vessel 'Skagens Rev' reported frost on 6 days during 7-15 Dec.²³

08 December 1939; Navigation closed at Kalix, Northern port in the Gulf of Bothnia²⁴.

11 December 1939; Navigation closed at Oulu. Last vessel sailed December 7²⁵.

17 December 1939; In Hamburg temperature sank to minus °7C²⁶.

18 – 31 December 1939; In Denmark, sea water temperatures dropped to below zero degree Celsius (selection): Aalborg 5 days (max low -1.6°C); Rodby Havn 7 days (max low. -0.6°C); Fredrikssund 7 days (max low. -1.8°C); Klinth Havn 3 days (max low. -0.5°C)²⁷. December mean temperatures at 08 a.m. for all Danish coastal stations are between +1.7°C and + 5°C.

¹⁸ Seewarte
²¹ Frankcom
²⁴ Frankcom
²⁷ Forklaring

¹⁹ Forklaring
²² Frankcom
²⁵ Frankcom
²⁸ DHI-Eisbeobachtung

²⁰ Forklaring
²³ Forklaring
²⁶ Seewarte

19 December 1939; Ice, which was reported in Kiel Channel (from Elbe to Kiel), Lübeck and Travemünde, remained for almost three months²⁸.

19 December 1939; Navigation closed to several ports in the Gulf of Bothnia, except with icebreaker assistance until end of December or middle of January²⁹.

21 December 1939; Ice reported in Schlei (north of Kiel), was to stay until 31 March 1940³⁰.

26 – 31 December 1939; Most Danish light vessels reported permanent frost (max -6.3° Lappegrund).

27 December 1939; Reported from Tallinn that Leningrad harbour was closed owing to ice³¹.

28 December 1939; Ice which was reported in Flensburg (at Danish border) lasted till 28 March 1940³².

2 January 1940; Narva and several other Estonian ports report fast ice; navigation closed³³.



January 1940
in
Southern
Baltic Sea

9 January 1940;
Heavy ice in Riga
–navigation only
possible for
powerful
steamers³⁴.

13 January 1940;
Gulf of Bothnia.
A minesweeper
and two patrol
boats dropped
depth bombs in
an attempt to cripple

a Russian submarine, which had trailed the small Finnish steamer, *Bore*, through the international water of the Gulf of Bothnia. (NYT, 14 January 1940).

²⁹ Frankcom

³² DHI-Eisbeobachtung

³⁵ Palosuo, p.92-93

³⁰ DHI-Eisbeobachtung

³³ Frankcom

³¹ Frankcom

³⁴ Frankcom

15 January 1940; Palosuo's meteorological assessment³⁵ reads: By 15 January, the atmospheric pressure in Greenland had reached a remarkably high level. As a low pressure simultaneously prevailed in Central Russia very cold air began to flow westward at high speed from the northern side of this low pressure, and a very severe frosty period began in the region of the Baltic. The outbreak of cold air resulted in an independent cold air pool ("Kaltlufttropfen") in Germany which persisted in the area for nearly a week. The cold air pool in the German area began to move on January 24 towards the Baltic region from where, reinforced, it pushed back to German territory on February 7. On February 12, its centre was in the region of Hamburg, from where, moving slowly, it arrived in East Germany about February 20.

17 January 1940; Heavy fast ice recorded at Tallinn and Riga³⁶.

17 January 1940; Copenhagen harbour full of firm thick ice. Extremely difficult conditions reported for shipping in all Danish waters. 23° frost reported during the night in Denmark. Baltic Sea frozen over as far as can be seen from Danish coast.

18 January 1940; Heavy ice reported in the sea off Riga and in Tallinn³⁷.

By the middle of January 1940 the first severe cold spell was firmly established.

Further details: Conditions in Europe Winter 1939-40, 2_11.

Ice conditions assessment

C.J. Östman summarized his detailed report (25 pages) on Baltic Sea ice conditions in 1940 as follows (excerpt):

"A survey has been given on ice covering the Swedish coast during the specially cold winter 1939/40. As regards the thickness of the ice it was generally greater than usual. Thus the values vary between 75-95 centimetres in the harbours of the Gulf and Sea of Bothnia, while the normal is about 70-75 cm. In the harbours of the Baltic, with exception for the most southerly ones, the thickness was 30-60 cm against normally 25-35 cm. The value 40-60 cm at the Swedish west coast is about two times the normal value."³⁸



³⁶ Frankcom

³⁷ Frankcom

³⁸ Östman' 1939/40

Cyclones and shells - War at sea events (2_21)

Introduction

The Theme

This section considers factors involved in the initiation of a process that forces heat out of a water body, for example, the sea, a bathtub, or soup in a cup. The more a “hot soup” is stirred, the more steam goes up in the air and the quicker the soup cools down to convenient eating temperatures. In oceans and seas the most effective external force to ‘stir’ the water is wind. Internal forces are horizontal or vertical currents. War at sea can have a similar effect.

Formation of Cyclones

In late 1939 oceans and seas in Northern Europe were treated exactly like any hot soup. Release of heat and vapour from the sea is the nucleus for the making of weather. Stirring the waters of the Atlantic and the formation of Atlantic cyclones might have influenced the weather. The fact is that the centre of low air pressure went from its statistically usual place south of Iceland in autumn 1939 (October-November) towards Scotland, 1,000 kilometres further east¹.

Stirring the sea area after a warm-up period in summer inevitably will increase evaporation. As the North Sea and waters around Britain saw most of the ‘war at sea’, a significant impact on the location of a low-pressure centre cannot be ignored. This statistical centre might be the result of cyclonic activities, which usually ‘squeeze’ heat out of the sea, and result in increased evaporation conditions in the North Sea, or wherever stir and shake of sea took place. Has the war at sea initiated, influenced, or supported this process? This section provides some examples for consideration. The weather produced some surprises during the first few months of war in late 1939.



Chain of causes – the butterfly effect

The ‘stirring of the sea effect’ is vaguely reminiscent of the ‘butterfly effect’. This thesis suggests that if a butterfly flaps its wings in one part of the world,

¹Rodewald, Winter

it can cause a storm in another part. More precisely, flapping of the wings produces a tiny change in the status of the atmosphere that, over time, can result in a much larger effect elsewhere. This effect is often used in connection with the “chaos theory”, which assumes that the atmosphere is fundamentally chaotic. As such, it is said, it is inherently unpredictable². There is no reason to question the ‘endless chain of causes’ for change in weather patterns. This investigation, however, is based on the assumption that oceans and seas dominate atmospheric processes. It defines climate as the continuation of oceans by other means^{3, 4}. As the war at sea in Europe’s home waters and out in the North Atlantic turned over a lot of sea, it can be assumed that the war at sea may have set atmospheric processes in motion.

Sea-air interaction

The case of the ‘steaming hot soup’ is mentioned as an example in an attempt to explain the ‘practical’ interaction between water surfaces and atmosphere. While full thermo-dynamical processes of heat (energy) exchange, radiation, conduction, and evaporation, are highly complex, the basics remain simple. Evaporation depends on the difference between the partial pressure of water vapour in the air and the vapour pressure of seawater. The greater the temperature difference between water and air, the greater energy exchange will take place. In the North Atlantic (between latitude 50-70°N) the exchange of energy, as compared to summer period (June – August), is 3-4 times higher during autumn, and 4-5 times higher in winter⁵. The difference will be greatest when the sea is warm and the air is cold and dry (period from autumn to end of winter). On the average, 100 grams of water are evaporated per year per square centimetre of ocean surface. It takes nearly 600 calories of heat (energy) to evaporate 1 gram of water⁶.

Actually, water is an excellent isolator. Once stored, heat is ‘safe and sound’ as long as it does not come into immediate contact with the atmosphere at the sea surface. Though this can happen on numerous physical conditions, one of the most effective methods is the stirring, mixing, or ‘turning upside-down’ of upper seawater layers, as is particularly done by winds generated by cyclones and anti-cyclone systems. Within one or two days a forceful gale can ‘squeeze’ heat energy out of the surface water layer, which may have been retained by a smooth surface for many days or even weeks⁷. Analysing reasons for the two major climatic changes during the 20th century, both of them in closest proximity to two World Wars, the following two examples *e.g.* turning the bathtub water around to get the right temperature for bathing

² Palmer

⁵ Svendrup, p.231

³ Bernaerts, Climate 1992, p.20

⁶ Parker, p.408

⁴ Bernaerts, Nature

⁷ Lumby

the baby, or stirring the soup to eatable temperatures, provide a basic explanation on the interaction between sea and atmosphere.

Investigation period

In this study, the first four months, until the winter of 1939/40 started in full, are considered particularly important. Before nature was on common course. During the initial period seas were still in their natural seasonal status in autumn 1939. After the war at sea had been going on for some time in various sea areas, these areas may have changed their 'climatology' quickly and nature 'accepted' the new situation. Cause and effect are difficult to match, especially when war goes on. However, the war in late 1939 marked the start of a global cooling period of four decades, in which the war at sea may have played an important role, especially from the moment naval warfare activities went global after the attack on Pearl Harbour in December 1941. (A)

Further details: (A) Ocean at war, 4_11; Sea system effected, 4_12.



War activities and weather events (Five examples)

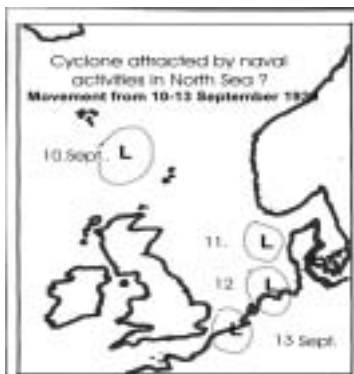
Example 1 - North Sea – 10 to 13 September 1939

On Sunday 10th September 1939, a low pressure with 1,000 mb originated north of Scotland. A move eastwards would have been the most likely course. But within the next 24 hours the seas were "hit" many thousand times of which a few number are given as example what kind of things happened:

- A mine sank a German destroyer near the entrance of the Kattegat in a mine field by a "detonation that was especially heavy as the destroyer was loaded with mines". (NYT, 12 September 1939). Only a day earlier the German government had revealed that three entrance zones to the Baltic had been mined. (NYT, 11 September 1939).
- Dutch freighter, 1,514 tons *Mark* was lost when it rammed against a mine in the North Sea 120 miles west of Vorupoer, Denmark, (NYT, 12 September 1939).
- Two British destroyers *Esk* and *Express* were laying sea mines in the German Bight.
- Submarines sank 7 ships in 2 days. (NYT, 11 September 1939).

On 11th September, the low pressure was close to the entrance to Skagerrak. How much have the above mentioned events influenced the formation/location of this low pressure? Later on, this low pressure (1,000mb) moved from west of Jutland, southwards to the Hoek van Holland area (12th), and then to Oostende/Belgium (13th). The movement of this low pressure through the North Sea may actually have something to do with activities along the “Westwall”, where a dozen or more German Naval vessels were laying many thousands of sea mines. On 15th, at 8 a.m., there was a small low-pressure centre (1,005 mb) north of Helgoland close to large sea mine fields.

Example 2 – Skagerrak – 15 to 16 October 1939



A low pressure (990 mb) moves from northwest of Ireland (12 October 1939) via the Irish Sea into the Southern North Sea at 985 mb (14th), and then, deepening further into 980 mb, moves via the German Bight to Jutland/Denmark (15 October). It generated gale winds and produced a wide rain front from the Eastern Baltic countries to Southern Norway. One can assume with certainty that the violent low took considerable heat and moisture out of seawater along its route. It is presumed that this ‘low’ may

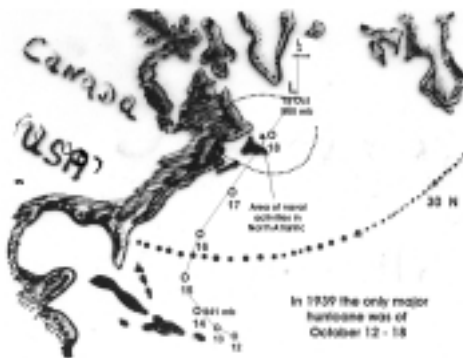
have been supported by a number of war related activities. As to what might have contributed to ‘atmospheric processes’ over Denmark’s waters is illustrated by reports of the following events:

- Off the Danish coast: “while pilot took US *Mormachawk* safely through (German) mines, with Danish and Greek merchant vessels tagging behind, American vessel’s helmsman grew increasingly jittery as five loose mines blew up 500 to 800 yards away from it. The motor ship heard later that a loose mine had struck the pilotless Greek steamer Kosti, going through the field behind it”. (NYT, 20 September 1939).
- Off Jutland coast: British cruisers hunting submarines in the North Sea (near Jutland) fought off German bombers. Bombers attacked repeatedly and anti-aircraft guns returned fire from decks of warships”. (NYT, 10 October 1939). Six bombs had hit the British cruisers, one bomber crashed into the sea, it has been claimed. (NYT, 11 October 1939). A bomb normally has a weight of either 500 or 1,000 pounds. “Nazi warships used decoys to lure the British fleet into position for air attacks off the Norwegian coast. Two 35,000 ton battleships, five heavy cruisers and a number of lighter

ships set out from their base in pursuit. A witness to this battle saw 150 planes. "There must have been at least 50 planes. More than 100 bombs were dropped". (NYT, 13 October 1939). A German flotilla sailing to the Norwegian south coast (8-10 October) was headed by battleship *Gneisenau* and accompanied by cruiser *Koeln* and nine destroyers⁸.

- Off Copenhagen shore: "Gales have loosened several hundred mines in the German mine field... drifting mines exploded on the coast near the suburbs (of Copenhagen), breaking windows and frightening citizens with terrific detonations. Marine crews have destroyed no fewer than forty-three mines from Koege Bay up to Amager Island, where about 100,000 Copenhagen residents live in a district comparable to Brooklyn. Along the whole southern coast, mine alarms often make it necessary to evacuate villages while experts empty or explode the mines. So many mines are floating around that it is impossible in the bad weather to destroy all of them." (NYT, 6 November 1939).
- On 21 October and 25 November 1939, German mines sank two German Coast Guard ships south of the Great Belt (Denmark); one of the ships exploded. (NYT, 26 November 1939).

Example – 3 "Erratic Hurricane" joins fighting in the North Atlantic? 12-18 October 1939



Main features of this story can be narrated briefly. On 10 October 1939, New York experienced the hottest October day on record. (NYT, 11 October 1939, p.26 – Commentary). Two days later a hurricane formed east of The Antilles. It took a north-north-easterly course on the 15th, intensifying rapidly.

After passing the Bermudas at noon on 16th, the cyclone rushed with hurricane winds towards Cape Race/ Newfoundland⁹, reaching a sea area in the North Atlantic on 17th that saw dozens of naval vessels in action. The hurricane was so fast and its course so erratic that the US Weather Bureau was unable to provide any warnings about the storm. (NYT, 19 October 1939). Another 'surprise' for the people of New York was the coldest weather on the 17th October, since the last winter, because steadily falling temperatures approached freezing point. (NYT, 18th October 1939). This was

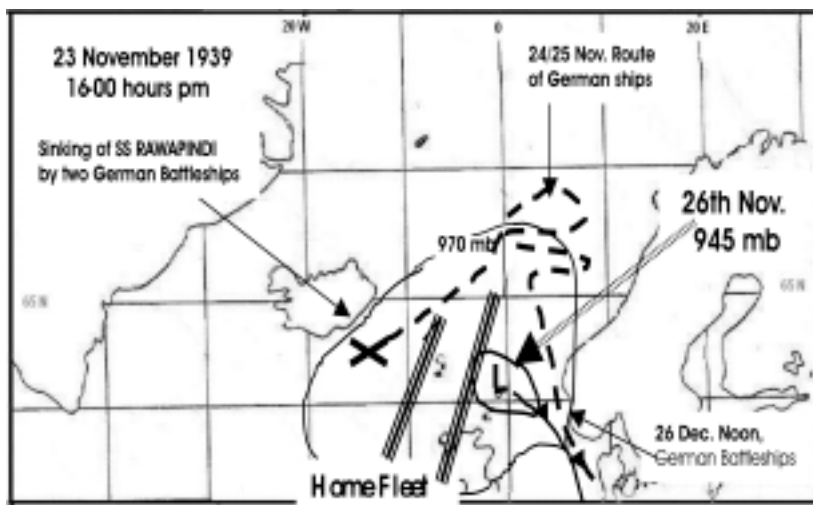
⁸ Potter

a record low for this season in New York and also in many other parts of the United States. (NYT, 19 October 1939). How could this happen? 10 October 1939 was the hottest day on record, and only 8 days later on October 17 there were record low temperatures.

In 1939, there was only one major hurricane¹⁰. It travelled in just 3 days (16th to 19th October) from the Bermudas to an area south of Greenland at high speed and further up to an area in the North Atlantic where the British Northern Patrol was active, as was a German submarine group of six. They sank eight vessels between 9th and 16th October. The pocket battleship *Deutschland* was active, and first convoys eastward and westward were on their way along with naval escorts. The British were active in laying a mine barrage on Faroe ridge from Faroe Island to Iceland. There were certainly even more activities that may have contributed to the “stirring up” of the sea surface thus giving the Atlantic air some vapour ‘to work with’.

Example 4 – The ‘Rawalpindi’ and the Cyclone, 23 – 27 November 1939

The first sea engagement of naval surface vessels in the North Atlantic occurred in late November 1939. This naval encounter was immediately followed by a rapid decrease in air pressure by more than 50 mb in 48 hours. Can a 15 minutes’ shelling of 600-pound shells produce sufficient ‘butterfly-effect’ to turn a modest low air pressure into a violent cyclone?



⁹ Hurd, Tropical

Extract from „Climate Change & Naval War – A Scientific Assessment 2005
Trafford on demand publishing, Canada/UK

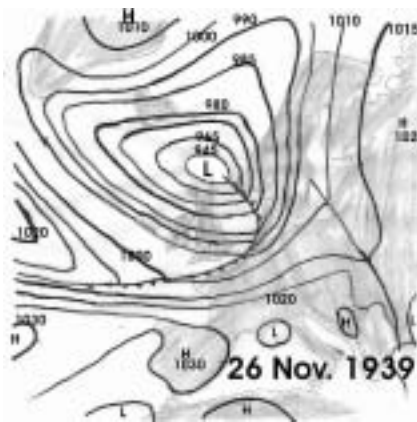
¹⁰ Hurd, North Atlantic

© Arnd Bernaerts

Weather was fair on Thursday the 23rd November 1939, Southeast of Iceland, about 200 miles west of the Faroe Island. The big and modern German battleships *Gneisenau* and *Scharnhorst* sailed in a flotilla of six naval vessels, when they saw HM Armed Merchant Cruiser *Rawalpindi* at some distance.

The sea was smooth in the late afternoon over a distance of about 7,500 metres, clear enough for the enemies to shell each other, when a tremendous explosion broke the merchant cruiser in two. A shell from one of *Scharnhorst*'s 11-inch guns had hit the *Rawalpindi*'s forward magazine. The Royal Navy ordered all of their Home Fleet (ca. 20 big naval vessels) to sail to the scene of action to hunt the German flotilla. But a squall arose and the German ships escaped in stormy weather.

The 16,697-ton *Rawalpindi* was no match for the 38,900-ton battleships each. The German battleship *Scharnhorst* fired the first salvo over a distance of 10,000 yards (NYT, 28 November 1939), but when the enemy loomed large *Rawalpindi* sought protection by dropping smoke floats into the sea and in her defence, replied with all her four starboard six-inch (100-pound) guns. (NYT, ditto). That was by far too little against the 11-inch (600-pound) shells German battleships could launch from their six guns in minute intervals. The battle was over at about 16-30 hours GMT. Germans took 28 survivors on board, from a total of only 39, and departed immediately before the first British cruiser (*HMS Newcastle*) arrived at the scene. "However, the other eleven crew members who had also escaped from the blazing ship were rescued by another British naval vessel.



Those eleven who landed at Glasgow told the story of the battle. The *Rawalpindi* burnt until eight o'clock Thursday night, they said, when she capsized on starboard side with all remaining crew (238 men). The cruiser attempted to follow German ships but weather was on the German side. Heavy rain and night fall served as a shielding curtain between German raiders and the British warship". (NYT, 28 November 1939). Probably rain may have come down due to the shoot out and the squall that arose could have come from the Atlantic water that was 'stirred' and 'turned' at the scenes of action.

Actually, within 24 hours of this occurrence, a low pressure (975 mb) appeared south of Iceland. In the early morning hours of 25 November 1939,

the air pressure over Iceland fell by more than 8 mb in three hours. The cyclone moved to the Orkney Islands and was down to 945 mb on 26 November. This was a weather development not everyone would have predicted. But in the late autumn the Northern Atlantic is extremely sensitive and the weather depends on conditions of the sea surface.

Example 5 – Arctic Christmas cyclone - 21-26 December, 1939 – connected to the war?

A highly spectacular weather event took place on the longest night north of the Arctic Circle off Roost (Lofoten) near the Norwegian port of Narvik. On 20 December 1939 a cyclone developed suddenly, pushing the prevailing air pressure down by 54.6 mb in 24 hours¹¹. The Swedish Weather Annual for December 1939 reported this event noting that the air pressure fell by 12mm within three hours¹². This matches with hurricane conditions. In addition to this development, the course of the cyclone over the next few days, according to weather charts of “Deutsche Seewarte”¹³ is quite interesting:

Thursday, 21 December 8 a.m. , 975 mb, ca 100 miles west of
Roost/Lofoten;
Friday , 22 December, 8 a.m., 970 mb, Lula/Sweden (north Baltic
Sea);
Saturday, 23 December, 8 a.m. 980 mb, Ladoga Lake;
Sunday, 24 December, 8 a.m., 980 mb, ca. 100 miles south of
Leningrad.

What triggered the development of this exceptional cyclone in the first place?

Heavy fighting between Finnish and Russian forces took place in the North-East and less than 300 miles away from where the new cyclone developed on 20 December 1939. It covered a frontage of 1,000 kilometres, stretching from the Barents Sea to the Gulf of Finland in the Baltic Sea. How many or how intensive military manoeuvres does it take to initiate or reinforce atmospheric events?

- 19 December 1939 – “Clear skies over Finland for the first time in two weeks provided ideal conditions for air attacks today, ...two squadrons of bombers came thundering under an icy blue sky and bombs were rained on the vicinities of Helsinki, Abo, Borga, Viborg, Hangoe and other vital points.” “A fierce air battle was fought over Borga between Finnish pursuit planes and Russian bombers, in which the bombers were forced to remain at an altitude

¹¹ Rodewald, Golfstrom

¹² Statens

¹³ Seewarte

of 15,000 feet.” “The Finns said the anti-aircraft fire against the Russian planes was so intense that most of the bombs, although aimed at military targets, fell wide off their mark”. (NYT, 20 December 1939).

- 19 December – “The Finns are using improvised tank bombs like those devised in the Spanish civil war, a combination of hand grenades and small gasoline cans”.
- 20 December – “The Russian drive was stalled in the far north by blizzards and temperatures 25 degrees below zero (minus 31° C)”. (NYT, 21 December 1939).
- 20 December – “Fierce fighting surged across Karelish Isthmus in sub-zero temperatures (below minus 17.8° C) today as the Russians lost hundreds of tanks in savage fighting and directed 200 Red Air Force planes in widespread bombing attacks on the rest of Finland. The roar of artillery could be heard from one side of the 65-mile-wide Isthmus to the other. Finnish aviation rose to meet Red Army aviators in fierce dog-fights and battles in the winter sky. ‘Much of the time I was unable to distinguish one plane from another. In zero cold the exhausts of the planes left comet-like streams, smoke trailing behind them for, as long as ten to fifteen miles occasionally’”. (NYT, 21 December 1939).
- 21 December – “Russians Retreat in Arctic from Finns, Cold and Snow”; “By mid-afternoon the Finns fighting in heavy snowstorm and sub-zero cold (Fahrenheit) were reported.” (NYT, 22 December 1939).

Further details: Russian-Finnish war, 2_41.

The list above presents only a very small number of events that actually took place in Finland, in the Barents Sea and in the Norwegian Sea where the new low-pressure centre originated from 19th to 21st December 1939.



U-boat bombed

Conclusion

From quite a number of cyclones, only features (development, strength, movement) of five lows in close context to military activities have been highlighted.

It seems difficult to categorically deny any impact of the war at sea on the composition of atmospheric air pressure; it certainly had. In September 1939 when Warsaw was in flames, exploding sea mines and the sinking of ocean liners forced cold water to the sea surface the air temperatures would have changed and subsequently the air pressure would have followed suit.

Although the examples given above in no way allow a final conclusion to be drawn on how each of these events contributed precisely to the forthcoming arctic winter in Northern Europe, the circumstances indicate that they should not be ignored. The sinking of the *Rawalpindi* was tragic, but in military terms it was “a small event”. Nevertheless, circumstances indicate that 11-inch-salvos by the *Scharnhorst* and the Home Fleet rushing to the scene, may have triggered the development of a cyclone, either by hastening it by a couple of hours, or by making it slightly more violent, or by letting it move a little further. After all, cannons of a battleship are obviously more effective than the flap of a butterfly’s wing. At least, the impact of an 11-inch shell is easier to detect. An exploding 600-pound shell is not necessarily a ‘fundamentally chaotic’ event for the sea and subsequently the air temperature.

Resultant Rain due to War – 1939 (2_31)

Aim of this paper

How World War II (WWII) drove Northern Europe into the hardest winter for one hundred years is subject of a number of chapters. This paper aims to show and discuss that not only Europe but the whole northern hemisphere fell prey to an arctic spell. United States and China experienced severe cold in January 1940, while Northern Europe was back in ice age conditions for the duration of two months.

While considering reasons for these occurrences of ‘cold’ conditions in the winter of 1939/40 in Europe, it should not be ignored that military activities on land may have disrupted the balance in the atmosphere by ‘squeezing’ humidity out of the air. Obviously, less water in the air, means colder but dry air. A place where this could have happened was the Western Front between France and Germany after the start of WWII, where more than 2 million soldiers had been put in positions along this Front.



It rained double or even triple the quantity as against recorded long-term mean precipitation in areas which were within a few hundred kilometres range of this war front line. Some regional areas had only days of rain during October. Just few weeks later the USA experienced extremely

dry air and also recorded low rain over the whole country. (A) In the end of December, winter set in and took the entire Northern Hemisphere in its icy grip by early January 1940, and remained frozen throughout the month.

Further details: (A) USA dried out, 2_32.

This paper attempts to focus attention on this ‘rain making’ phenomenon during the initial war months in 1939. Only at this stage of WWII did the war activities directly interfere with common ‘nature and climate’. Thus this short period of time can be regarded as having gone through a direct ‘clash’ between common nature – in a statistical sense - and civilization. This can be

compared with the sudden major eruption of a volcano with global implications. The time it took for the spread of volcanic ash and dust around the globe after the huge eruption of the volcano Krakatoa in Indonesia on August 27, 1883 until the end of the year may serve as an example¹. In this case nature took charge and after a relatively short period of time, the atmosphere returned to ‘equilibrium’, making it difficult to prove the source and reasons for this specific meteorological event. It would assist in researches on climate changes, if the impact of WWII - during the first few months – was under consideration, or when the war after having entered its 1st, 2nd or 3rd years has to be studied in detail. The German meteorologist R. Scherhag², observed a “great disruption in circulation” during the winter of 1939/40 only, even though the winters that followed in 1940/41 and 1941/42 were also of similar nature. However, before the second and third winters of the war, military activities took place throughout the year, giving nature time to move from ‘equilibrium to equilibrium’ without a sudden disruption. Although this aspect is admittedly rather difficult to explain, one particular practical example is part of this study. This example demonstrates a link between excessive rain in Central Europe (see this chapter), and the record ‘dry air’ in the United States from October to December 1939 (next chapter). This is a substantial evidence of anthropogenic influence. This proof, on a meteorologically sensitive issue, is presumably valid only when WWII had just started. Why did the USA, after a ‘normal’ year, suddenly receive only very dry air for three months, while the war in Europe that ‘squeezed’ water out of the atmosphere only a few weeks earlier?



pave way for arctic air should be regarded as a temporarily contributing factor only.

Before continuing it should be stressed once again, that the making of the arctic winter 1939/40 in Northern Europe is primarily a regional affair due to war at sea in adjacent waters. Making the atmosphere rain and

Limitations of this paper

This paper does not propose to discuss physical/chemical processes in a hydro-dynamic environment. It aims only to show that with the start of WWII certain events occurred which cannot be related to conditions other

¹ Wexler, Spread

² Scherhag, 1951

than war activities. However, war activities in this respect can mean quite different things as mentioned below:

- 1) The war machinery and its activities penetrate the atmosphere directly or indirectly with physical/chemical means, which subsequently set processes in motion that eventually produce rain; e.g. the raging of war along the Western Front and many other battle fields and the burning of cities all over Poland during September 1939.
- 2) The war machinery and its activities also stirred and mixed the seas and oceans, with the following results:
 - a) accelerated evaporation,
 - b) raised vapour and initiated flow of air, from Northern Scandinavia or from Russia to the North and Baltic Sea;
 - c) Presumably cold air (colder than seasonal average) forced humid air into increased precipitation, e.g. in Central Europe.
 - d) It started to 'block' the West Drift, commonly moving maritime air from the Atlantic through Western Europe, via the North Sea. Instead, continental air flew in from the east.
 - e) The continental air, colder than maritime air, that had been coming via Scandinavia or the 'corridor' of the Southern Baltic Sea/Poland and North Germany along until it reached the North Sea, could have been a major contributor to the excessive rain along and behind the Western Front.
- 3) The war in China was also a factor which should not be ignored. However, very little material from the Far East had been available for this study which can at best help to attempt a basic assessment. Furthermore war in China, would have had hardly any impact on the autumn weather in Europe. However, some relevance of this war on drought conditions in the USA in late 1939 cannot be ruled out.
- 4) The topics mentioned below will be discussed in greater detail in chapters:
 - North Sea cooling (2_16), concerning items 2a-d;
 - Lost West Drift (2_12), concerning items 2c-d;
 - War in China 1939 (2_33), concerning item 3;
 - USA dried out 1939 (2_32), concerning item 3.



The lack of rain during the German invasion of Poland in September 1939 will receive attention. This attack which was an extremely destructive military operation could possibly have deprived Poland of 'normal' rain. If so, it could serve as a proof that military activities along the Western Front kept Poland rainless. It would be a sadly ironic event, if true (see below). The situation on Polish territory during September 1939 may have also contributed to the blocked 'West Drift' in a minor way.

A final aspect, although speculative, should also be mentioned here. The military onslaught on Poland during September 1939 was, until then, the most massive military land war operation in such a short period of time. It ended after four weeks, with Warsaw burning for many days. All the material that had been thrown into the atmosphere, like that of the burst of the Krakatoa 56 years earlier, could have served as 'condensation nuclei', if it had managed to travel a little farther to the west, contributing to heavy rain along the Western Front, or influencing rain conditions further east, e.g. when Russian and Japanese forces waged a week long battle on the boarder between Outer Mongolia and Manchuku in August and September 1939. (A)

Further details: (A) War in China, 2_33.

Basic Factors

Weather modification has been studied intensively by scientists since WWII. A number of programmes and experiments have been conducted³. There are actually quite a few theories as to which activities of humans may affect the natural causes of weather⁴. Anthropogenic aerosols can have an impact on the weather process. Rainmaking experiments have been performed on the assumption that some clouds precipitate inefficiently, or not at all, because they are deficient in natural nuclei. In some cases clouds only need some "seeding" to make them produce ice nuclei, snowflakes and raindrops.

- Rain processing: Water can condense in the air by the use of molecules as condensation nucleus. Condensation occurs on a wide variety of aerosol particles e.g. particles of dust, salt, desert sand or smoke. These particles when condensed, usually lead to cloud formation. Among the highly efficient condensation nuclei are salt particles produced by the evaporation of sea water. But it now appears that particles produced by man-made fibres also make a major contribution⁵.

The biggest rain making experiment may have started in the autumn of 1939. Since the 1st of September a lot of 'seeds' had been pushed into the air. It was

³ Sewell

⁴ Parker, pp 541-547.

⁵ Parker, p.100

possible for them to ‘make’ rain and this is precisely what happened. A several hundred kilometre long military defence zone between France and Germany, the Maginot Line and the Westwall, were put into full operation immediately after the war had started. It began to rain significantly on the continent along the Western Front. It rained more than the average in September, even more heavily in October and November and still more in December before Northern Europe was dragged into arctic weather conditions with frost, ice and snow until March 1940. Only the first four war months, viz. September to December 1939, are the subject for the following study as, latest by December 1939, European weather had lost its “natural texture”.

Meteorological data indicate that excessive rain was fed by “seeding” due to war. Rain fell within close distance of war activities in the West, while further East the Poles waited in vain for rain.

Although neither big battles nor “shoot outs” occurred along the huge defence system in the West, everything was done to improve defence capabilities and to prepare two million soldiers for the worst. Therefore both fronts were busy day and night with transportation, construction, survey, training and military encounters. The first substantial clash saw 700 French tanks and planes moving seven miles over the Saarland border, while 300 air planes attacked German positions in the Aachen industrial region and munitions area, some 125 miles further north, (NYT, 7 Sept.1939), encounters that occurred since then frequently. At the same time British troops were landing on the continent rapidly, while German planes targeted England for the first time, (NYT, ditto) the Royal Air force bombed the isle of Sylt. (NYT 9 Sept 39). There were several encounters which occurred in numerous places along the Western Front and elsewhere every day.

Poland without rain in September 1939

According to an assessment by the German meteorological service, September 1939 was considerably wet from the upper and middle of the Rhine region (Duisburg/Cologne to Frankfurt/Darmstadt) eastward to Silesia. Large parts of middle and southern Germany received double than average rain. On 4th September, a wet warm high pressure front (1015 mb), approached from the Atlantic, which brought to the whole of West Germany mist and rain, but moved quickly eastwards. The warm front was almost exactly in line with the French/German Westfront at 8:00 a.m. on Sept 4th, the with centre of a low pressure close to Luxembourg and rain coming down in Germany, leaving nothing for Poland⁶.

⁶ Seewarte

On 11th September, a low pressure (1,000mb) originated west of Jutland, moved south to the Schelde area (12th), and to Belgium (13th), bringing lots of rain to North Germany and excess rain of 50mm to 100mm to Southern Germany. This low-pressure cyclone moved through the North Sea, close to the sea mines that the German Navy had started to lay quickly, across the middle of the North Sea, at the outer edge of the German Bight. This could possibly be the first example of a cyclone being “attracted” by sea war activities which produced “evaporation”. (A) At least the cyclone also gave Poland some rain before the 13th of September but it was too little, too late.

Further details: (A) Cyclones and shells, 2_21.

A report (NYT, 15 Sep. 1939) that Warsaw received heavy rain, was proved wrong. It was only a drizzle in most areas (NYT, 17 Sept. 1939). By then Warsaw was encircled. The Red Army marched into Poland from the East. Days of the Polish Republic were numbered. The Nazis had deployed 5,000 planes in Poland (NYT, 25 Sept. 1939). On September 25, 1939, 240 German planes bombed Warsaw, dropping 560 tons of bombs, including the first 1,000 kg bomb. Meanwhile 1,000 batteries shelled the city. 30 transport aircraft dropped 70 tons of fire-bombs. Warsaw was on fire for many days. Poland surrendered. There was nothing but dust and ashes from burning cities eastward around for a couple of days or weeks. Did this dust help to pour horrendous rain on New York in early November 1939, recording 1.4 inches in one day? (NYT, 6 November 1939). But some of the dust could also have been moved by easterly winds to the Western Front contributing to excessive rain in Central Europe.



The German Meteorological Service makes the following assessment for September 1939: Precipitation in North Germany is markedly below the mean averages. The opposite occurred in all other parts of Germany, with

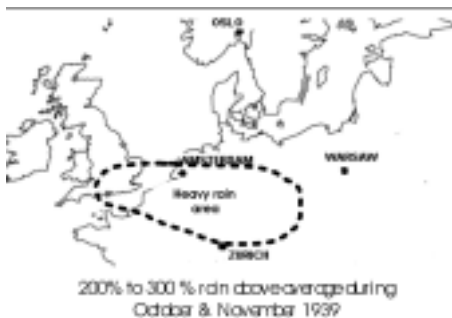
significantly higher quantity of rain than mean averages. The September 1939 precipitation in percentage terms of average figures (1851-1930) for some places in Germany had been as follows:

Berlin-Dahlem (197 %); Frankfurt/Oder (197 %); Breslau (204 %); Ratibor (210 %); Karlsruhe i.B. (208 %); Stuttgart (199 %); Ulm (226%); Wuerzburg (215 %); Muenchen (212%)⁷.

October 1939 – Raining ‘Cats and Dogs’

In the West, Middle and South Germany volumes of rain recorded at most observation stations was more than double, in some cases even 3.5 times more than usual, as follows: Augsburg 366%; Noerdlingen 362%, Kaiserslautern 336 %, Wuerzburg 316 %⁸.

Due to the war situation there is hardly any weather related documentation available. With respect to Darmstadt it was reported that it would be necessary to go back to the year 1882 to find a similar volume of precipitation during a period of three months, i.e. Sept.-Nov., as the autumn had never been so wet since more than 100 years⁹. The nearby city of Frankfurt a. M. recorded: 137%, 265%, 237% during the time in question.



The Black Forest and Freiburg i. Br. recorded 30 days of rain; a number of other locations had up to 24 days of rain¹⁰.

An eye-witness report may serve to illustrate the special situation at the Western Front. According

to the New York Times, by mid October the West Front saw a ‘Nazi Attack with 100,000 men’ and the following weather:

“Bad weather prevailed today on the entire Western Front, where conditions could not have been worse for offensive operations. The Germans were obliged to use railroads for amassing/transporting reinforcements, with the result that all lines of communications were clogged throughout the day. Rain and fog kept allied planes grounded.

French artillery whipped the German front line positions, roads and railroads with shrapnel to hamper operations.

⁷ Witterungsbericht

⁸ Witterungsbericht

⁹ Fischer, Nasser

¹⁰ Witterungsbericht

Rains aided flood in Rhine and forced evacuation of several Westwall blockhouses opposite Strasbourg. They also caused the Moselle to rise to a level eleven feet above previous week's level. The Blies and other small streams flowing into the Saar River were flooded and the terrain already badly pocked by artillery fires in Monday's bitter fighting, was covered with water holes". (NYT, 18 Oct. 1939).

Southeast England recorded rainfall of more than three times above average in October 1939. Greenwich saw a higher rainfall only in 1888, and before that in 1840¹¹. Greenwich total for October (6.16 in.) and November (4.13 in.) together –10.29 inches – was the highest ever since recording had begun at Greenwich¹². Similar conditions had been observed at Camden Square (London), where hours of rainfall are recorded as follows: October 77.3 h., November 96.7 h. These were 50 hours higher than the average¹³.

Holland also reported rains throughout the month of October 1939. (NYT, 2 Nov. 1939). Similar condition presumably prevailed in Belgium and Northern France as well. In January 1940 NYT correspondent G. H. Archambault reported while staying with the French Armies: "the autumn of 1939 was one of the wettest known". (NYT, 26 Jan. 1940).

November 1939 – Rain Spares France – At least for now

"Germans continued to shell Forbach. Artillery hammered as forcefully as wet weather impeded action by infantry", (NYT, 06 Nov. 1939). Another headline of the NYT (16 Oct. 1939) reads: "French Still Wait for Reich's Attack – Rain Impedes Fighting".

On 19th October plan "Yellow" for the invasion of France was finalised. On 7th November commencement of the invasion plan was postponed for the first time. A Blitzkrieg was not advisable with 'General Mud' in company. Hitler wanted to go ahead and would have sent the Wehrmacht across the borders in late 1939, but for excessively wet autumn weather conditions made even Hitler think twice.

Indeed, November 1939 weather conditions were not much better than in October. In general it was a bit too warm and too wet, 200% and more of normal for the season, in Hannover, Aachen, Kassel, Frankfurt a. M., Magdeburg, Ulm, Wuerzburg.

By November 19/20, 1939; The Rhine had been rising again and there was heavy flooding in Switzerland.. (NZZ, 20 Nov. 1939); Heaviest flooding of rivers in Belgium and Holland made navigation impossible. Further rise of water was expected. (NZZ, 29 Nov. 1939)

¹¹ Lewis ¹² Correspondence, Greenwich ¹³ Correspondence, Camden

That the quantity of rain in East-South-East of Central Europe in late autumn of 1939 was excessive, was confirmed by a NYT report in mid December: "The waters of the Danube River has begun to recede from the record December flood level, and the speed of current, caused by swollen tributaries, relaxed." (NYT, 13 Dec. 1939).

Saxony and Switzerland - December 1939

Nothing remains to be said on the rain making issue in this chapter. Saxony with its capital Dresden had similar autumn rains as in other parts of Germany. Snowfall in Finland, close to Russian-Finland war theatre, since end of November is certainly a factor which should not be ignored. See: next section.

In Saxony, Dresden reported heavy snowfall lasting 36 hours on December 6 and 7, corresponding to 50 litres per square-metre, with a decrease in temperatures to minus 7°C. Some thing similar had happened 57 years before, in 1882¹⁴.

Switzerland also experienced a very wet autumn as well, with heavy flooding in late November, and saw last rain on December 11. However, Zürich experienced only some drizzle in early January 1940. (NZZ, 14 January 1940).

Russian-Finnish battles in December

War inside the arctic circle is a serious matter in terms of weather making, especially if the fighting starts at the meteorologically most sensitive time, i.e., from the end of November and till the end of December.

Few weather indications from early December may serve as an illustration (NYT):

Dec. 03: Bad flight weather; Mist and rain on Friday; Snow falling in Helsinki yesterday.

Dec. 04: Blinding snowstorm aids defence; North of Ladoga Lake ice is still thin; Petsamo: bitter cold and severe snowstorm.

Dec. 05: Snowstorm hinders foe; snow is piled deep at various sections of the battle line; early setting in of winter conditions; Helsinki feels safer in snow storm; snowstorm slowed down activities on both fronts and air.

Weather conditions turned worse and worse. The Red Army was completely unprepared for this early winter onslaught by nature and suffered heavy losses in terms of men and material. (A)

Further details: (A) Russian-Finnish war, 2_41.

¹⁴ Naegler, Schneefall

With regard to ‘rain making’, the Russian – Finnish winter war during December 1939 should certainly not be ignored in an overall assessment on the driving ‘hydrodynamic’ forces leading to these winter conditions. Shelling and bombing would certainly have contributed to heavy snow and snowstorm conditions, and precipitation that would otherwise have gone down further east somewhere before or behind Moscow.

Summary

The suddenness and extreme of the war winter of 1939/40 had been such an extraordinary meteorological event that every aspect relating to its rapid build up should be elaborated and weighed. The atmosphere during the particularly climatically sensitive autumn months of September to December in the Northern Hemisphere reacted immediately. Rain that came down in Western Europe as heavy downpour since the war had started on September 1st had not been available in the USA during the corresponding period. While mostly excessive rain occurred in Europe in October, four weeks later the USA experienced a record dry month with only 44% precipitation of average for the whole country during November 1939

What followed the ‘humidity gap in the air’ was, *inter alia*, a ‘disruption in circulation’ all over the Northern Hemisphere. Excessive rain in Europe and dryness in the USA were certainly not the only causes for this ‘disruption’. Temporary ‘absence of water’ in the atmosphere provides a perfect explanation as to why not only Europe fell prey to an ice age winter, but also China and the USA had suddenly experienced a very severe January 1940. In fact, cyclonic activities are weakened by less water in the air.

This study aims to highlight that actual “rain forcing” in autumn 1939 might have contributed to free the path for masses of arctic air to move deep south with little resistance from maritime air in all northern parts of the Northern Hemisphere. The severe winter, the coldest for one hundred years in countries bordering most war-affected seas in Northern Europe, did not come ‘just out of the blue.’ The clue to this is to be found in the war at sea. The distant impact of the war in Europe and in the winter of January 1940 in the USA and China had presumably contributed to ‘rain forcing’ in Europe that evidently brought a record dry autumn spell to the States, and subsequently paved the way for arctic air to dominate over areas usually under the influence of the West Drift. In this respect it is worth noting that East Siberia and Canada had been actually too warm (about + 7°C) at the same period of time¹⁵. An interesting aspect, while assessing events in late 1939, is that nature was still in its ‘pristine status’, allowing observations or deviation to be assessed on an uninterrupted or ‘mixed-up’ data basis. The autumn 1939 provides a very important period in this respect.

¹⁵ Scherhag, 1951

Extract from „Climate Change & Naval War – A Scientific Assessment 2005
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USA winter weather 1939/40 caused by war (2_32)

The United States pushed into the cold

New York experienced the hottest day on record on October 10, 1939 (NYT, 11 Oct. 1939, p. 26 – Commentary). Ironically, only a few days later the same City, and many other parts of the United States, were shivering under a steadily falling thermometer approaching freezing temperatures (NYT, 18 Oct. 1939), dropping to a record low level for that date. (NYT, 19 Oct. 1939). At the same time, war had started in Europe in earnest, and the North Atlantic took the first torpedoed vessels down to its bottom, while Japan was in combat with Chinese forces. Could the extreme conditions New York experienced in mid October 1939 have been caused by WWII activities? This section will leave it to anyone's guess as it will focus on the question why the following January 1940 proved to be record cold for the USA which was not expected either.

The first signs of a 'real' winter emerged at Christmas time 1939, when except for the Deep South and California, the United States had snow and extreme cold. (NYT, 26 Dec. 1939). Winter came earnestly in early January 1940, with a frigid wave that gripped most of the United States (NYT, 06 Jan. 1940). Icy north-westerly winds swept over New York with force, on January 06, causing temperatures to drop to an average of 10 degrees Fahrenheit below normal (NYT, 07 Jan.40). From the Continental Divide to the Atlantic Coast there were strange occurrences as compared with normal weather conditions. Frigid waves even touched the northern parts of Florida. (ditto). Was this due to the unusually dry air in November 1939, as noted by Dr. James Kimball in 'The New York Times' on January 7th (NYT, ditto), which actually continued well into December 1939 (see below)? That December had not been as dry as November in statistical terms, maybe due to



snow that fell with the Christmas cold, e.g. between St. Louis and Louisville the snow generally was 6 inches deep¹.

USA weather map
November 25th, 1939.

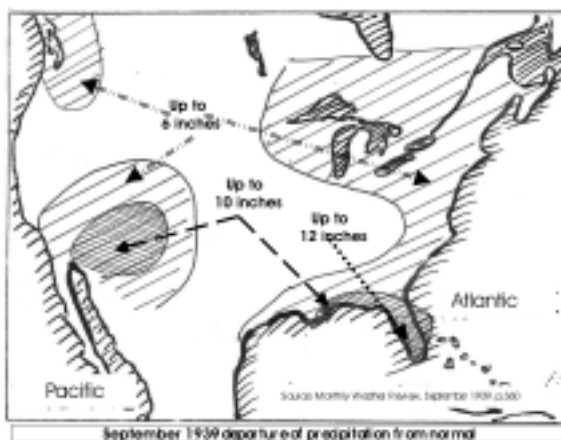
The less humid the atmospheric air is, the more easily it can be replaced by colder air. If the amount of water in the atmosphere is less than average, the

¹ Brooks, 1939/40

‘vacuum’ thus created, is filled by colder air. If the atmosphere is ‘water free’ as on the moon, the temperature range there is about 300°. It is somewhat plus 150° or higher when the sun shines, without the sun shining, temperature on the moon is in the range of minus 150° or lower. On the earth the water in the air makes the difference in global air temperature. About the equivalent of a three-metre deep water layer of the ocean surface is usually in the atmosphere. If a portion of this water ‘has been taken out of the air’ for a brief period of time during sunless winter months, arctic air sweeping in from the North Pole region may cause a frigid blast causing surprising cold winter conditions.

This paper will show that, the United States had an extremely dry weather from October to December 1939, presumably caused by the war in Europe.

USA deprived of rain - October to December 1939



Since the initial days of September 1939 a battle line several hundred kilometres long stretched through Central Europe from the Strait of Dover and the Helgoland Bight to Switzerland with attacks of various intensity; missions and encounters taking place every day. As has been explained in the previous chapter,

it rained excessively in Central Europe, presumably due to military activities over land and at sea. In early September the Russian and Japanese Armies met in a severe encounter in the Outer Mongolia (A), whereby California experienced an eight days heat wave, since about September 16th followed by a severe tropical storm (NYT, 25 September) and record rain. It was the heaviest September rain in Los Angeles' weather history and it broke the worst heat wave in Weather Bureau records, as measured by intensity and duration. It lasted for eight days. (NYT, 26 September). During summer 1939 an El Niño was active off South America's coast. Made events in Europe, China and the equatorial Pacific Ocean record weather in California?

Further details: (A) War in China, 2_33.

Accepting the status-quo as it is, it might be interesting to see whether it is possible to identify a reflex action in the air that reached North America from the French-German, or the Polish-German front in Europe, e.g. from the fires burning in Warsaw during the second half of September, or even from the fighting in China? Actually, with regard to contemporary climatic conditions in the United States, it is a fact that the weather changed suddenly from too wet to too dry between summer 1939 and winter 1939/40.

The winter of 1938/39 in the United States was abnormally wet particularly in the eastern United States and in the Southwest, with the larger part of the country having above-normal conditions. The spring of 1939 was exceptionally dry with only a few States from the Mississippi Valley eastward having somewhat more than normal rainfall. From the Great Plains westward, all States experienced deficient rainfall. The summer was relatively wet eastward of the Great Plains, except in the Northeast, where rainfall was deficient in almost all sections. The fall season was extremely dry over large areas, although amounts of precipitation were a little bit above normal in Utah, Colorado and Arizona. For all the areas eastward of the Rocky Mountains it was the driest fall on record².

With regard to anthropogenic rain making due to military activities in Europe and Asia, and due to the fact that 'aerosols' from battle fields, for example in Poland during September 1939, could easily make their way to the USA, it should at least be mentioned here that in California precipitation in September 1939 was 370 % above normal (Alabama, 119%; Arizona, 335%; Nevada 327%; Utah 261%). However, in most States, September 1939 was unusual dry.

A closer look at a few areas, which received above normal rain in the fall of 1939, reveals that it was the result of high precipitation levels in September. Figures given below show the percentage of normal precipitation. It may be noted that the States named by Martin above³ are normally very dry during the months October–December.

Utah	Sept. 261 %	Oct. 119 %	Nov. 15 %	Dec. 37 %
Colorado	Sept. 83 %	Oct. 50 %	Nov. 32 %	Dec. 51 %
Arizona	Sept. 335 %	Oct. 55 %	Nov. 136 %	Dec. 29 %

Source: Martin

South Dakota and Wyoming recorded a mere 1 percent, and North Dakota and Nebraska recorded just 5 percent. Only Arizona exceeded the 'average mark' by 136 percent. November 1939 was the driest month in the history of the whole of the USA, the rain average about 30 percent lower than the 'dry

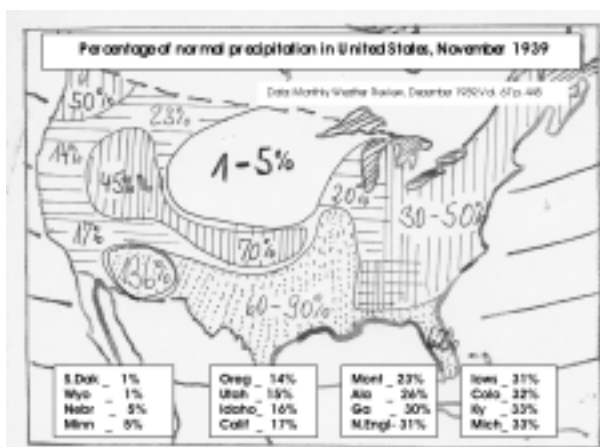
² Martin

³ Martin

spring average', with the driest months May (72 percent) and April (94 percent).

The total precipitation in the 42 States of the USA during the closing months of the year 1939 as listed by the Monthly Weather Review⁴ was as follows:

Percentage of normal precipitation in 42 States (figures in approximation)	October 78%	November 44%	December 71%
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The 'unusual dry air' during November 1939 was quickly noticed (NYT, 07 Jan. 1940). The recorded dry months of October to December 1939 coincide perfectly with the excessive rain in central Europe where the battles were being waged.

Natural variation?

The Timing: The 'timing' between excessive rain in Europe and the dry months in the United States is a perfect indication of the relationship between both the events. Any 'interchange' between dry and wet air takes time. A dry or humid air body can exist up to several days or a few weeks. An 'air body' needs a couple of weeks to circle the Northern Hemisphere. Interaction of air between the hemispheres may take several months, as based on observations made on the movement of air in the wake of the outbreak of the volcano Krakatoa in 1883^{5, 6}.

Scherhag, who analysed a disruption in the circulation of air in the winter of 1940, states with regard to air movements that there must have been a subsequent air-body-transfer (Massentransport) from the Southern Hemisphere towards the Arctic⁷. This remark makes it clear, that 'dry air' from Europe could have circled the globe for some time before a 'humidity gap' could be refilled. It also confirms that there was a 'humidity gap' in the

⁴ Martin

⁵ Furneaux

⁶ Wexler, Spread

⁷ Scherhag, 1951

first place. If this ‘dry-out’ had not been caused by military activities, what else caused it?

The Regions Covered: January 1940 was cold in all Northern Hemisphere regions, viz. North America, Northern Europe and Northern Asia. This is a strong indication that there was too little humidity in the air (as proved in the case of the USA - above), giving arctic air a free path to penetrate deep into southern regions. At least the first cold wave in the second half of December 1939 can be clearly related to the prevalent ‘dry air’ condition. Additional causes (e.g. snow cover) may have contributed to subsequent weather events. Nevertheless, presumably the ‘dry air’ in late 1939 did not move away quickly, due to scant sunshine available during the winter season in the northern hemisphere.

Difference between the winters in USA and Europe: A further piece of evidence is the fact that the severity of the winter in the United States was over by the end of January 1940⁸, whereas extreme winter conditions prevailing in Northern Europe even during February 1940 show that a number of countries, e.g. Holland, Northern Germany and Southern Scandinavia, experienced their coldest winter for more than a 100 years.

Lower air circulation: Only few years after WWII, Richard Scherhag, came to the conclusion that the winter of 1939/40 was the result of a comprehensive general disruption in the atmospheric circulation, which could be regarded as a ‘prototype’ for a weakened circulation⁹. Altering downwards temperature in seas and oceans inevitably causes disruptions in atmospheric air movements.

Summary

This paper provides a number of indications to show that the war in Europe may have significantly influenced winter weather conditions over large distances. In this case, North America had a severe cold January in 1940. However, this was presumably initiated by a lack of usual rain in the United States during the months of October to December 1939 in the first place. This could have been caused by excessive ‘rain making’ on account of military activities along the Western Front in Europe. The evidently low humidity in the atmosphere in late 1939, made it easy for arctic air to travel forcefully over the northern parts of the continents in the Northern Hemisphere at low temperatures. The timing of ‘dry air’ and the invasion of polar air into all continents in the Northern Hemisphere with severe impacts also in the USA and China seem to suggest that this was not a mere natural variation.

⁸ Martin

⁹ Scherhag, 1951

Although the ‘dry-USA’ aspect together with the factor ‘forcing rain by military activities’, are highly interesting contributory events, neither is,

however, the principal cause of the severe war winters of 1939-42 in Europe, (A) and the subsequent global cooling from 1939 until the 1970s. (B) But these aspects should be regarded as a collection of ideas for further investigation and study.

Further details: (A) Three war winters, 3_31; (B) Sea system effected, 4_12.

That something strange had been going on with the weather many thousand kilometres away from the war in Europe, is briefly indicated by an excerpt from Brook’s paper¹⁰:

“Paradoxically, most of eastern Canada north of latitude 48° was above normal, with temperatures running up to more than 25° F above normal north of latitude 58° and 18°F above normal in the interior of Alaska. Missouri was actually as cold as the Hudson Bay region for the month”.



Higher winter temperatures during El Niño events have been observed in eastern Canada and Alaska and during other events also. However, in winter 1939/40 the key for this erratic behaviour was the war in Europe.

¹⁰ Brooks

War in China - 1939 (2_33)

Russian meet Japanese for duel

The development of extreme winter weather of 1939/40 from the North Pole down to the middle latitudes all over the northern hemisphere, may have received some contribution from the Far East as well. With less water in the air, the arctic air more easily could move south. North America wondered what had caused the unusual dry air in November 1939. (NYT, 7 January 1940).

At the time WWII started in Europe, the Chinese-Japanese undeclared military conflict was already in its thirty-second month. By February 1940, more than 4 Million people had died and another 5 Million had been wounded. (NYT, 11 February 1940). This fighting should not be ignored while studying anthropogenic weather changes, although there is little scope to pay much attention to this distant scenario. It would certainly be difficult to pinpoint “major activities” that may have had an impact on the atmosphere. Actually in 1939 a major flood occurred in China. A vast area in the North China Plain was submerged, and the water in the streets in Tianjin (120 km south-east of Beijing) was two meters deep, so that boats were the only means of transport for upwards of two months. It is claimed that the deaths-toll was 20,000.



In 1939 artillery barrage, troops charging and daily bombing had become deadly routine in China for many months. What role did the war machinery on China's soil played in making the flooding happen? This question needs to be answered one day.

In this context the encounter between Russia and Japan in autumn 1939 (NYT, 17 September 1939) should also be mentioned here. Only ten days before WWII started, on 20 August 1939, the Red Army with 100,000 troops went into combat with the Japanese Army comprising 70,000 soldiers (Kwantung Army) at Nomonham, a place on the boarder between Outer Mongolia and Manchuku in fine weather¹.

The Soviet forces had brought with them more than 400 tanks, 200 heavy guns, 400 armoured cars, 500-700 planes and several thousand tons of ammunition, shells and bombs to the Far East, over a distance of 3,000

¹ Coox

kilometres. Presumably not less military equipment would have been available for the Kwantung Army, which eventually was the loser in this event with 20,000 men dead, when the truce was signed on September 16. The Soviet's use of massive tanks and their superior military tactics proved successful. Both sides suffered considerable losses. The weather also may have contributed to the losses. This continental region is usually relatively dry. One wonders whether the air had become 'drier' during several days of fighting. Two brief reports quoted by Coox² may serve as an illustration:

- Rain had been coming down for days, and on the night of 9th September, weather became very cold, wind became gusty, and snow fell hard. Some progress was seen on the bridge by the early afternoon on the 9th, but as the storm intensified, the river current quickened and water rose to two and a half meters.
- On 10 September: 'Firing by the infantry began at 6 a.m. followed by an artillery duel. Five hours later, rain changed to snow again, and it grew intensely cold'.

This happened in a region, which generally saw little rain. The contribution by war on "rain forcing" was presumably very small with no impact outside the combat zone. But by mid September 1939 with WWII already two weeks old with Poland almost doomed, a several hundred kilometres defence lines activated between the English Channel and North Sea to Switzerland, above average rain fell in central Europe (A) It seems reasonable to ask whether this event in Europe has had a direct link to lack of rain in the USA, as the NYT (8 October 1939) reported under the headline "Wheat Belt Frets as Rains Hold Off". At the same time California and Arizona had had very high precipitation (370% and 335% above normal during September). But for this, it might be reasonable to link the impact of war activities in Europe to lack of rain in the USA. (B)

Further details: (A) Rain-Making, 2_31; (B) USA dried out, 2_32.

Effect of record cold January on War in China

The war in China saw many battles in late 1939. In January 1940 very cold air crept in from the North. The following newspaper reports illustrate the event as under:

- CHUNGKING, China, January 23, 1940 – The Chinese claimed an important victory over Japanese forces north of Hupeh today. A Japanese column of 20,000 men advancing northwards from Suihsien, was said to have been crushed at Kaocheng by frontal attacks. Meanwhile snow blankets cover most of the battlefields and record cold weather is gripping most parts of China.

² Coox

Extract from „Climate Change & Naval War – A Scientific Assessment 2005
Trafford on demand publishing, Canada/UK © Arnd Bernaerts

- HONK KONG, January 23, 1940 (AP) – In battles fought in pelting snowstorms and bitter cold, the Chinese reported today that they had repulsed a Japanese attack near Chaocheng in Western Shantung Province, foiled a Japanese attempt to break through their lines in Northern Hupeh Province, and dynamited two trains carrying Japanese troops in Shantung.
- SHANGHAI, January 23, 1940 – More than 650 bodies of homeless beggars and refugees who perished overnight in freezing cold and from malnutrition were found in Shanghai's streets and vacant lots during the last four days of intense cold. More than 450 of these victims are babies or small children. All parts of China reported unusually harsh weather, with snow falling in some districts where it was unknown for twenty years. Due to poverty and homelessness of millions of refugees, based on Shanghai figures, the civilian toll consequent to the cold wave was estimated at about 65,000.
- HONG KONG, January 23, 1940 (AP) – The cold wave had extended today to China's southernmost provinces of Kwangtung and Kwangsi. In Changsha, capital of Hunan Province, the weather was described as the worst in twenty years. A blinding snowstorm swept Lanchow (Lanzhou), capital of Kansu, where the cold was said to be the severest in China.



And the undeclared war went on. Early in February 1940 the Chinese amassed 400,000 troops at Nansing and fought a 10-day battle suffering heavy losses with about 40,000 dead and 80,000 wounded. (NYT, 08 February 1940).

Few Events in China in late 1939

2 October 1939; "...that since the Japan-Soviet armistice on the Manchukuo border numerous columns of Russian troops have been entering Sinkiang Province using highways connecting Urumchi with Trans-Siberian Railway. Some reports, which are causing alarm in Japanese military circles, declare that the Soviet Union already has nearly 300,000 armed men inside Sinkiang. ...During the last two months immense war supplies and a number of airplanes from the Soviet reached China,...". (NYT, 3 October 1939). Japan claims to have crushed 19 Chinese divisions; which left Chinese with 10,000 dead on the field. The Chinese estimated that 20,000 Japanese had been killed or wounded in the last two weeks. (NYT, ditto).

28 December 1939; 100 Japanese airplanes raided the city of Lanchow for three days in the biggest air attack since hostilities started 30 months ago. Lanchow, is an important centre on the supply route from Soviet Russia to Chungking. (NYT, 29 December 1939).

28 December 1939; Chinese Army spokesman asserted that Japan had suffered 100,000 casualties in December on all fronts. (NYT, 29 December 1939).

03 February 1940; The Chinese undertook mine-sweeping activities in the Yangtze River last year destroying 1,021 mines. Last month they destroyed an additional 37 mines. (NYT, 3 February 1940).

3 February 1940; Nanning/China. Constant field artillery and machine gun fire and bombing including two surprise thrusts by Japan, were said to have demoralized at least 140,000 of the 400,000 Chinese soldiers amassed to defend attacks on Nanning. (NYT, 03 February 1940).

3 February 1940; Six church leaders call for embargo on Japan, saying: "With our aid over 2,000,000 lives have been lost in the conflict. Between 5,000,000 and 10,000,000 other lives have been lost as a result of the war and over 60,000,000 people have been rendered homeless and destitute." (NYT, 3 February 1940).

Summary

While looking for reasons as to how arctic air could move southwards with little resistance immediately after the war had started in Europe, the fighting in the Far East in the autumn and winter of 1939/40 should not be ignored. It is probable that, impacts of the war in China may have contributed, even though to a small extent by way of 'cloud seeding' only, to the severe war winter of 1939/40 experienced in Europe as well as to those two war winters that followed. The theory of climatic changes due to the impact of wars at sea seems irrelevant with regard to Japan's war with China from 1938-1945. The Sino-Japanese struggle was a land based war, with nothing in comparison to the naval warfare in Northern European waters in autumn 1939.

Russia invades Finland, December 1939 (2_41)

Weather and War in the Arctic Circle

After World War II had ended William Mandel¹ pointed to the fact that much lower temperatures were experienced in the winter campaigns around Leningrad during the Soviet-Finnish fighting 1939/40, around Moscow and Leningrad in 1941-42, and around Stalingrad in 1942-3. The implication was much wider and more serious than Mandel's statement suggests. However, the Russian-Finnish war 1939/40 lasted from December 1939 until March 1940 over a full first war winter.

On 30 November 1939, the Soviet Red Army invaded Finland. The first month turned out to be a nightmare for the Red Army. They were taken by surprise by extreme weather conditions occurring totally unexpected in the high north of Europe.



Some of the weather conditions reported from the front lines (see below: e.g. Chronicle, December 24) were totally unusual for the time of the year and deviated so much from the average that it was hard to believe that such a condition could have happened without any reason. Like the excessive rainfall in Central Europe from September to November 1939, precipitation in the Arctic Circle might have been caused by earlier military activities as well.

Actually, the first month of fighting, in a region roughly

500 kilometres north and south of the Polar Circle, took place in almost permanent night conditions. Finland, separated from the Atlantic by the Scandinavian mountain ridge, and situated between the Barents Sea and the Baltic Sea is a climatologically sensitive region during the final weeks of the year. Drier air above Finland or colder water of the adjacent seas, would make the weather more continental. If military activities in Finland forced increased precipitation, the less humid air could flow further east into Russia.

¹ Mandel

If the Russian continent west of the Ural lacks moisture, the area will support the development of high pressure and the flow of cold air to West Europe. When naval and coastal defence activities forced a quick release of stored summer heat out of the Northern Baltic Sea, the influence of low-pressure conditions diminished. Once that happens, the Baltic Sea area is an easy target to icy air from the Arctic or Siberia.

In the North Sea and the Baltic Sea the extraordinary war winter of 1939/40 originated. (A), with its centre in the coastal zones of Germany (Hamburg). While the foundation for this winter had been laid long before December, as explained in other papers. (B), the war in Finland should certainly not be ignored for the overall outcome of meteorological conditions during the first war winter. For this reason a fairly comprehensive picture of the main military activities and weather situations observed in and around this Nordic Country shall be taken into account.

Further details: (A) Cooling North- and Baltic Sea, 2_16, 2_17; (B) Lost west wind drift, 2_12.

In the first place, this assessment will demonstrate the quick succession of unusual weather events, which show that the common atmospheric processes over Europe at this time of the year was influenced by something uncommon, resulting in an aggressive, extreme and erratic reaction. This was particularly intensive in the high north and at Europe's Mediterranean coast. The latter region with its extraordinary weather events around New Year's Day 1939/40 will be covered in a separate paper.

It can hardly be overruled, that major military activities went 'hand in hand' with hectic weather appearances and deadly low temperatures, for example:

- The invasion of Finland had started - and 'blinding snowstorms' waged along the 750 miles of the battle line on December 4/5.
- The Russians started a major offensive on about December 20th/21st - and blizzards occurred and the temperature fell to below - 30°C.
- Joseph Stalin had amassed 300,000 of his best troops to attack Finland from the north and the east (NYT, 27 December), sometimes shelling Finnish positions up to 48 hours continuously



- and snowstorms and unusual low temperatures reached the battle fields (December 29th/30th).

- Russia deployed 2,000 large guns (NYT, 18 January), which spat one hundred shells every minute (NYT, 01 February) - but ‘a pitiless deathly cold laid a glacial cover on Russia’s war machinery tonight with phenomenal 54 degrees-below-zero temperatures’. (NYT, 18 January).

This is hardly a matter of mere coincidence. The following chronicle, which covers the time from 30th November 1939, to the end of February 1940, makes one wonder whether all these vagaries of weather were caused by the course of nature. Although the extremely harsh winter of 1939/40 clearly originated further south in the North and Baltic Sea, the fighting around the Arctic Circle also might have contributed to it in one way or other.

To provide an example of average temperatures under the Arctic Circle in Finland, the following table shows relevant figures (www.weather.yahoo.com) from the fairly close Russian city of Murmansk, which is less than 50 km away from Petsamo, the most northern point of Finnish defence:

Average winter temperatures in Murmansk/Russia

High	Nov. -3/-1°C	Dec. -6/-4°C	Jan. -8/-6°C	Feb. -9/-7°C
Mean	Nov. -5°C	Dec. -9°C	Jan. -11°C	Feb. -11°C
Low	Nov. -8/-6°C	Dec. -13/-11°	Jan. -15°/-13°C	Feb. -15/-13°C

In comparison (see Chronicle, below), temperatures were measured in Finland, e.g. on 24th December 1939 (-34°C); 30th December (-40°C); 2nd January 1940 (-40°C); 17th January (-48°C).

Background of the Conflict

In 1936, Finland was already warned by Russia that it could adopt a “forward strategy” and occupy the country if it would intervene in a war between Russia and Germany. The German-Soviet non-aggression pact and secret protocols of 24 August 1939, assured the Russians that they could pursue their interests in Eastern Europe from Finland to Poland. Stalin lost no time to increase Russian influence and presence along these lines. When Stalin did not get the concession he was looking for from a Finnish delegation a war plan was prepared in late October, assuming that a military offensive would last no longer than 15 days. The Germans persuaded Finland not to give in and diplomacy ended, when the last Finnish delegation returned from Moscow on 13th November 1939. Stalin ordered the mobilisation of the Red Army along the entire Soviet-Finnish boarder, while the Red Naval Commissariat prepared for operations in the Gulf of Finland and the Baltic

Sea. More than a dozen submarines patrolled the coastal waters, and the first sea mines were laid.

Some early events to be mentioned

22 September, 1939: “It is also reported here that Russia has mined a part of the White Sea (Barents Sea) as if expecting attacks in Arctic waters”. (NYT, 22 September 1939).

10 October 1939: “Finland’s fleet was mobilizing tonight at the port of Abo in readiness to transport troops and war material to the near-by Aland Islands if they are threatened by Russia.” (NYT, 11 October 1939).

20 November, 1939: Due to the early onset of winter and sub-zero (Celsius) temperatures on 20th November only one of three battleships from the Baltic Fleet was able to reach the Lake Ladoga via the Stalin Canal to Schusselburg². The weather charts of the ‘Deutsche Seewarte’ indicate snowfall since 18th/19th November, but not any serious minus zero temperatures³.



30 November, 1939: In the Barents Sea from the North Cape to the city of Murmansk naval activities were increased. The Northern Fleet was ordered to provide artillery support to the Red Army. On November 30th the Russians had four armies with 450,000 men stationed along the 1,000 kilometre-long front, 2,000 tanks and 1,000 aircrafts, all-in-all about one quarter of the total strength of the Red Army at that time. When the Red Army began systematic shelling and bombing of Finland at 06-50 hours on the morning of 30th November, the Soviet-Finnish winter war had started⁴.

² Van Dyke, p.46

³ Seewarte

⁴ Van Dyke, p.69

Temperatures in North Sweden – December 1939

In the north of the neighbouring country Sweden, the city of Harnöesand at the Gulf of Bothnia, the average temperature deviated from the normal average in December by -3° to -5° C as follows:

- December 01 - 06 = insignificant
- December 07 - 08 = strong (more than 5 degrees lower)
- December 09 - 12 = moderate (ca 3 degrees lower)
- December 13 - 15 = strong (ca. 7-10 degrees lower)
- December 16 - 23 = moderate (up to ca 3 degrees lower)
- December 24 - 28 = very strong (ca 10 to 17 degrees lower)
- December 29 – 31 = moderate (2 to 5 degrees lower)

In Stockholm, about 400 km south of Harnöesand, December temperatures remained fairly close to the average, except during the days December 24 - 28, with 5° to 11° degrees below average temperatures⁵.

The temperatures in Sweden in December 1939 do not necessarily indicate that in the fairly close neighbourhood conditions have been very different, as illustrated in the chronicle below. Actually, the mean temperature for Sweden in December 1939 was -2.5° C. This is a deviation of only -1.2° C from the average means of -1.3° C, based on 30 years (1901-30) of temperature recordings.

Weather data from Finland in December 1939

Concerning the war and weather situation in Finland this investigation relies primarily on information provided by daily newspapers. It seems clear that some exaggerations may have occurred. During wartimes war parties regard propaganda, misinformation and even plump lies as legitimate. Even weather reports are not excluded. The following information indicate some extraordinary weather conditions prevailing in many military operations. Some reports indicate extreme deviations from previous December conditions. The investigation presents them without comment and verification. Insofar the reader is advised to use other sources as well for obtaining a complete picture on Finland's weather conditions in December 1939.

Of particular help in this respect could be a Finnish website: www.warwinter.com, concerning the Russian-Finnish War, indicating that the December weather 1939 was widely within common range, if not even

⁵ Statens

mild, until the fourth week. Only since 20th December temperatures dropped sharply and remained extreme low until the end of the year. The average temperatures in December 1939 were: Helsinki (-4,4°C), Sortavala (-8°C), Kajaani (-8,5°C), and Sodankyla (-18°C). The situation at Finland's northern outlet to the Barents Sea, Petsamo, is not particularly mentioned on www.warwinter.com.

Naval activities in the Gulf of Bothnia

The Gulf of Bothnia has the deepest sea bottom in the Baltic Sea. In hydrodynamic terms this semi enclosed bay stores considerable heat at a very sensitive climatic site thus far up north. Any activities in these waters during the winter season are particularly crucial. There had certainly been a lot of transportation of minerals from Sweden and Finland to Germany going on until the ports had been closed by ice. Presumably Sweden and Finland also took a lot of preventive measures along their coastlines, e.g. patrolling, mining and naval exercises. But the Gulf of Bothnia did not become a serious naval battlefield. Nevertheless, the few known activities, some of which are listed in the following, might also have contributed to the development of the temperature, snow and ice-conditions in the far North.

It is a well known fact in navigation, that one can delay the icing of a water way by moving a ship through the water that pushes the icy-surface water down to replace it with warmer water. This will work only for a short period and the averted icing will return more severely. The assumption that such techniques had been used too keep Haparanda (see previous section) and other ports at times of war open as long as possible, is not too far-fetched.

3 – 20 December 1939: At least five Russian submarines operated in the Gulf of Bothnia sinking the *Bolheim*, a German steamer of 3,324 tons off Rauma, on 10 December, 1939⁶.

15 December, 1939: Swedish navy was laying mines in Aaland's South Kvarken Straits, in an attempt to prevent submarine activity in the Gulf of Bothnia⁷.

25 December 1939 to 19 January 1940: Two more submarines enter the Gulf of Bothnia, a third boat is lost on a Finnish mine barrage in the passage to the Gulf. The others sink the *Wilpas* (775 tons) off Vasa on 28th December, the *Fenris* (484 tons) on 5th January about fifty miles south of Umeaa; while one submarine attacks a convoy in Aaland waters on 13th January⁸.

⁶ Rohwer

⁷ Van Dyke, p.64

⁸ Rohwer

5 January 1940: Russian submarine shelled the *Fenris* of 484 tons, in the northern part of the Gulf of Bothnia today. The attack revealed that Russian submarines have penetrated deep into the gulf, by passing through heavily mined waters of the Aaland Islands. (NYT, 6 January 1940).

13 January 1940: Gulf of Bothnia. A mine sweeper and two patrol boats dropped depth bombs, in an attempt to cripple a Russian submarine which had trailed the small Finnish steamer *Bore 1* through the international waters of the Gulf of Bothnia. (NYT, 14 January 1940).

The Russian-Finnish naval activities in the Gulf of Finland are included in the following chronicle.

Naval activities in the Barents Sea

Any extensive naval activities in the Barents Sea near the Finnish port of Petsamo or on the route to Murmansk or in the White Sea (see above, NYT, 22 September 1939), may have had an impact on the weather conditions in the region. However, it is difficult to get a clear picture in this respect.

The Russian Offensive - A Chronicle

Thursday, 30 November 1939

30 November 1939: The Finnish army's strength along the entire 750-miles north-to-south front is said to be 250,000 regular troops and 100,000 men of the volunteer corps. (NYT, 4 December 1939). About the southern Karelian front it was said that a force of about 40,000 Finnish troops is pitted against 70,000 or 80,000 Red Army troops. (NYT, ditto). "All in all, the Leningrad Military District command (Red Army) enjoyed a material superiority over the Finnish army by 3:1 in manpower, 80:1 in tanks, 5:1 in artillery of all types and 5.5:1 in aircraft"⁹.

30 November 1939: "Military observers believe the Russian forces in the Leningrad district and the Lake Ladoga region to total at least 5,000,000 men. The number of available tanks is given as 1,000 and the number of fighting planes as 500." (NYT, 7 December 1939).

30 November 1939: Gulf of Finland „The (Russian) commanders of transport ships and torpedo boats were so afraid of being attacked by Finnish

⁹ Van Dyke, p.39-40

submarines, that they set off depth charges every 15 minutes, or whenever an unconfirmed sighting of a periscope was made, resulting in a total of 400 depth charges being dropped by the end of the operation that day”¹⁰.

30 November 1939: “...the troops, tanks, warships and bombing planes of the Russian war machine had:

Bombed from the air the cities and towns of Helsinki, Kotka, Kemjaervi, Kittikai, Petsamo, Utti, Kaipalais and Viborg.

Seized the four undefended Finnish islandsafter heavy aerial and naval bombardments.

Seized Finland’s vital ice-free port of Petsamo on the Arctic Sea only three miles from the Norwegian frontier, after heavy serial bombings and artillery battle with Finnish troops.

Sent warships westward through the Gulf of Finland, perhaps for bombardments against Helsinki from the sea.

Occupied several centres in the Finnish territory....

Bombed from the air and attempted to seize the peninsula of Hangoe, seventy-five miles west of Helsinki.....

Bombed the 3,900-ton Finnish warship *Ilmarinen*.....” (NYT, 1 December 1939).

30 November - 1 December 1939: The Baltic Fleet cruiser *Kirov* and two destroyers shell the Finnish island of Russaro, which returns the shelling¹¹.

30 November 1939: (Bergen, Norway) Two British destroyers and a damaged submarine (T-53, 1,300 tons) put into port of Fosteroy, north of Bergen, today, reportedly after a battle with German planes at sea.

30 November 1939: On the first day of invasion, Baltic Fleet bombers spotted the two Finnish battleships anchored off the island of Russaro. Within two hours the Baltic Fleet command sent eight long-range bombers. As the ships had meanwhile disappeared, the squadron dropped their 600 bombs on Helsinki; two additional squadrons were sent out to destroy naval air fields around Helsinki; they managed to destroy 12 airplanes and several hangars while losing two bombers of their own by Finnish anti-aircraft fire¹².

Friday, 1 December 1939

1 December 1939: “Bombs dropped on Helsinki, civilians were hastily leaving in the mist and rain in the northern winter”. (NYT, ‘The Week in Review’, 3rd December, 1939).

¹⁰ Van Dyke, p.54

¹¹ Rohwer

¹² Van Dyke, p.55

2 December, 1939: "Snow began falling on Helsinki, where relief workers sought to extinguish fires and to clear away rubbles before Russian bombers returned again with a rain of death". (NYT, 'The Week in Review', 3 December 1939).

Friday, 8 December – Second week

8 -9 December 1939: The Finnish coastal batteries on Koivisto carry out gun duel with Baltic Fleet shelling forces, consisting of the battleship *Minsk*, two destroyers and three gunboats¹⁴.

10 December 1939: "Violent fighting in knee-deep snow on Finland's eastern frontiers at the Arctic Circle was reported today". (NYT, 11 December 1939). "Hostilities in the northern sector were said to be proceeding in weather 4 degrees below zero (-20° C)". (NYT, ditto). "In addition to the Red Army troops killed in battle, many others were reported to be dying of cold and exposure after being isolated from their supply trains and bases in the snow-piled wastes". (NYT, ditto).

Friday, 15 December – Third week

17 December 1939: "Last week's fighting took place on days, that saw the thermometer in Central Finland go no lower than 4 degrees below zero (-20° C), while in Karelia temperatures ranged from 5-14 degrees above (-15 to -10° C). (NYT, The Week in Review, 17 December 1939).

18 December 1939; The German weather service observed that cyclone activities in the high North have become strongly active again, at the same time the extreme cold had been continuing in that area. At Spitsbergen, in a strong northerly air current -15° C has been measured, providing the European arctic sector with a very cold air mass¹³.

18 December 1939: A squadron of the Soviet Baltic Fleet (one battle ship *Oktjabrskaja Revolutsija*, five destroyers and further support vessels) shelled the 254mm Finnish coastal battery at Saarenpaa on Koivisto, with the arrival of a further battle ship, *Marat*, on the 19th. Also planes bombed the island¹⁴.

„The Finnish coastal batteries have been in lively combat for the last few days. Time and again they have been attacked by Russian planes or bombed. The coastal batteries around Koivisto have been especially exposed to bombardments". (NYT, 20 December 1939).

¹³ Seewarte

¹⁴ Rohwer

20 December 1939: A highly spectacular weather event took place in the longest night north of the Polar Circle off the Roest (Lofoten), near the Norwegian port of Narvik. On the 20th December a cyclone developed suddenly, pushing air pressure down by 54.6 mb in 24 hours.¹⁵

20 December 1939: “Russian drive was stalled in the far north by blizzards and temperatures 25 degrees below zero F (-31° C)”. (NYT, 21 December 1939).

20 December 1939: “Fierce fighting surged across the Karelish Isthmus in sub-zero temperatures (below -17.8° C) today, as Russians lost hundreds of tanks in a savage drive, they deployed 200 Red Air Force planes in widespread bombing attacks on the rest of Finland. The roar of artillery could be heard from one side of the 65-mile-wide Isthmus to the other”. (NYT, 21 December 1939).

21 December 1939: “Russians retreat from Finland, in Arctic cold and snow”. “By mid-afternoon the Finns were reportedly fighting in heavy snowstorm and subzero cold”. (NYT, 22 December 1939).



21 December 1939: At the Arctic front the Russians retreat in less than minus 30° C. (Neue Zürcher Zeitung, NZZ, 22 Dec. 1939). North Finland temperatures down to -30 °/-36° C. (Hamburger Anzeiger, 22 Dec. 1939).

Friday, 22 December 1939 – Forth week

23 December 1939: Heavy snowstorm reported from Latvia. (Hamburger Anzeiger, 27 December 1939).

23 December 1939: During the third week of war Russians launched several major offensives against the Mannerheim-Line positions. They employed a huge number of flaks of medium and large calibre up to 20-cm and showered a countless number of shells continuously on Finnish positions, lasting for 48

¹⁵ Rodewald, Golfstrom

hours. They further attacked Finns with 200 tanks and several hundred airplanes, followed by a large number of infantry. (NZZ, 24 December 1939).

24 December 1939: Report by James Aldridge (extract from NYT, 25 December 1939): “The cold numbs the brain in this Arctic hell, snow sweeps over the darkened wastes, the winds howl and the temperature is 30 degrees below zero (minus 34.4 ° C). Here the Russians and Finns are battling in blinding snowstorms for possession of ice-covered forests. ...I reached the spot just after the battle ended. It was the most horrible sight I had ever seen. As if the men had been suddenly turned to wax, there were two or three thousand Russians and a few Finns, all frozen in fighting attitudes. Some were locked together, their bayonets within each other’s bodies; some were frozen in half-standing positions; some were crouching with their arms crooked, holding the hand grenades they were throwing; some were lying with their rifles shouldered, their legs apart....(T)heir fear was registered on the frozen faces. Their bodies were like statues of men throwing all their muscles and strength into some work, but their faces recorded something between bewilderment and horror.” (NYT, 25 December 1939).

25 December 1939: Extract from a journalist’s report: “Today was even colder than yesterday, the mercury hovering around 15(F) below zero at midday (Viborg region)... (w)e saw six Soviet bombers plunging over the edge of the city, leaving trails with smoke, the result of their exhausts freezing in the intense cold. Some minutes



later more groups appeared from all directions until thirty planes were wheeling over the city and its environs. ... (t)he bombs ranged in size from 30 to 200 pounds..(T)here were bomb craters up to thirty feet in diameter and fifteen feet deep....(T)hese explosions were as freakish as tornadoes”. (NYT, 26 December 1939).

26 December 1939: Finland carried the war to Soviet soil yesterday with a drive across the border seventy-five miles from Russia’s vital railway to Murmansk, Helsinki reported. But Russia claimed a victory in the Suomussalmi region, continued the bombardment of Viborg and bombed many other southern towns. (NYT, 26 December 1939).

27 December 1939: Joseph Stalin has amassed 300,000 of his best soldiers on the eastern and northern fronts... (T)he Finns estimate that the Red Army has lost 4,000 men in fighting in the extreme north alone in the last three

days...(T)he Finns said they had identified sixteen Russian divisions confronting them (each about 18,000 men). (NYT, 27 December 1939).

27 December 1939: Viborg: The weather last night and today aided the Finns. Low clouds prevented Soviet air observation and a resumption of intense bombing activities of the last few bright days. Lower temperatures are prompting snow, which the Finns are hoping for. Finnish artillery is blasting huge holes in the ice of frozen lakes... (T)he Russians, forced for three weeks to conduct their campaign along canalised lines because of the chain of interlocking lakes, today took advantage of several days of 10 to 15 degrees below zero weather (-23/26° C) and directed a massive attack against the Finnish left wing across the ice. (NYT, 29 December 1939).

28 December 1939: “For two days the writer (James Aldridge) has been at the front with an advance post of the Finnish Arctic Army. From a hut somewhere between Kemijaervi and Salla, I have been watching the Finns conducting a remarkable war successfully against overwhelming Russian forces in Winter cold, 30 degrees below zero, and amid blinding storm. ...(in) the bitterest weather conditions of any war ever fought”. (NYT, 29 December 1939).

Friday, 29 December 1939 – Fifth week

29 December 1939: At the Petsamo Front heavy snowstorms are continuing. (NZZ, 29 December 1939).

30 December 1939: According to reports from Kirkeness in North Norway mighty snowstorms blew over North Finland. Horrible cold prevailed in the Finnish north front area. Temperatures have fallen to 40° C below zero, a cold of such magnitude is seldom seen in this area in December. Due to this weather experts consider it impossible that larger military actions can be waged. (Hamburger Anzeiger, 30/31 December 1939).

31 December 1939: According to a review of the first month of the war, the Russians now are attacking on seven fronts with 700,000 men. Russian losses are estimated at 35,000 killed, 100,000 wounded, 332 tanks destroyed or captured. (NYT, 31 December 1939)

Early 1940 – January and February

Only a few significant weather data are mentioned. The Gulf of Finland was completely frozen since mid January.

2 January 1940: Soviets lost 12,000 men in battle on lake. Finnish patrols on ski are hunting down the bewildered remnants of the 163rd Red Army

Division, which was surrounded and shattered last Friday and Saturday. A blizzard is raging. The main battle took place on the ice of Lake Kianta in a temperature of 40 degrees below zero (-40°C). (NYT, 3 January 1940).

2 January 1940: (South Finland); A heavy snowstorm originated over Finland. (NYT, 5 January 1940)

4 January 1940: NYT Commentary comments on the reports of James Aldridge (see above: 24 December 1939, and 2 January 1940): "If reports are true, someone in Moscow blundered. The Russians were not ready for such cold weather". (NYT, 4 January 1940).

5 January 1940: A Politiken's newspaper correspondent tells of the strangest evacuation she had ever seen – not women and children, but animals, in 40 degrees below zero Fahrenheit. There are more than 200,000 reindeer in Northern Finland. (NYT, 6 January 1940).

7 January 1940: Report by K.J. Eskelund from Karelian Isthmus (extract): A wave of arctic weather stopped all Russian attacks on the Karelian Isthmus today. However, the Soviet artillery began a strong bombardment late in the afternoon. ... (I)n spite of several layers of wool and fur coat I myself nearly froze this afternoon when, with the temperatures 25 degree below zero (-32°C), I accompanied a group of foreign journalists on a visit to a Finnish company several kilometres behind the front lines. (NYT, 8 January 1940). The weather has proven an unexpected ally to the Finns, who usually look for the coldest temperatures not until February and March. In Helsinki in Southern Finland it was 15 below (-26°C). Ice forming in the Gulf of Finland has severely crippled the Red Fleet. (NYT, 8 January 1940).



8 January 1940: A record frost today covered Northern and Central Russia, with the thermometer at 31 degrees below zero Fahrenheit (-35°C), and impeded normal activity. (NYT, 9 January 1940).

10 January 1940: Russia now has 400,000 men and more than 2,000 large guns on the Karelian Isthmus, a high Finnish office declared today. (NYT, 11 January 1940).

13 January 1940: Riga/Latvia; The bitterest cold wave of years, which sent temperatures in the Baltic countries to as low as 40 degrees below zero Fahrenheit, ended abruptly today. The mercury rose rapidly to a few degrees below zero Fahrenheit. Parts of the Baltic Sea have frozen over, and floating and pack ice are likely to interfere with shipping for some time. (NYT, 14 January 1940).

18 January 1940; Helsinki: “Pitiless, deathly cold laid a glacial cover on Russian’s war machinery tonight... near Salla, above the Arctic Circle. Phenomenal 54-degrees-below-zero temperature (-48°C) restrained the Russian air forces, ...and apparently immobilised Russian ground forces, which have been attacking on the Karelian Isthmus. (NYT, 18 January 1940).

18 January 1940: Temperatures of more than 50 degrees below zero Fahrenheit were reported from several points. At Nickby, northeast of Helsinki, a temperature of 58 degrees below zero was recorded – the coldest since 1878. It was 11 degrees below zero in Helsinki. (NYT, 19 January 1940).

20 January 1940; “Thus they are able...to relieve men exhausted by a week of fighting in temperatures plunging to 60 degrees below zero”. (NYT, 21 January 1940, p.23, left 1st column).

21 January 1940: “The cold polar air remained stagnant over vast areas of Europe and North America. Result: Some of the coldest weather in half a century. In Moscow the temperature on 17th January dropped to 49 degrees below zero Fahrenheit (-45° C), and in parts of Finland to 58 degrees below zero. Such temperatures can be measured only on alcohol thermometers, because mercury freezes solid at 38 degrees below zero.” (NYT, 21 January 1940, Weekend in Review, Title: War in the Cold).

27 January 1940: Helsinki. “Victims in the coldest Winter in sixty years...” (NYT, 27 January 1940). Koivisto lost, Finns admit. (NYT, 27 February 1940).

Ending of Winter-War 1939/40

On 12th March 1940, a treatise is agreed upon to end all hostilities.

“On 20 March, 1940, a final meeting of representatives from the Soviet and Finnish governments was convened at Kremlin to formally conclude a war, which had never been formally declared.”¹⁶

¹⁶ Van Dyke, p. 189

Turkey Earth Quake – 27 December 1939 (2_51)

The Quake

“Once more a great disaster has visited a country, caused this time not by man’s inhumanity to man, but by a gigantic force of nature.” - “It is not likely that the new upheavals will teach the geologist anything new. They are evidence that nature has not yet finished with the earth.” - “What we urgently need is some method of predicting quakes and warning a threatened population.” (Extracts from the NYT Commentary on 29 December 1939).



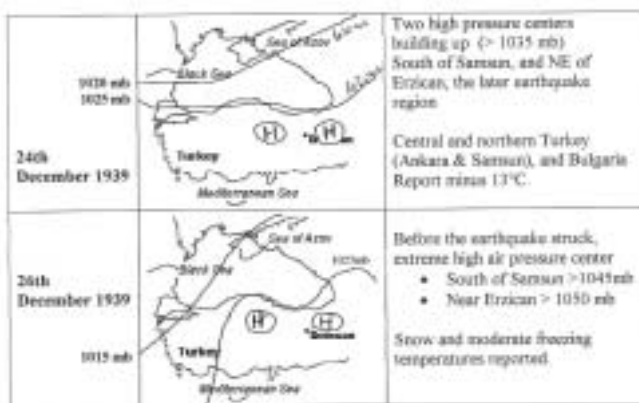
On Wednesday 27th December 1939 (after foreshock on 26th 23:57:16h G.C.T), a devastating earthquake in the north-easterly highlands of Anatolia shook the whole of Turkey, at 1:57:35 hours a.m. local time. There had been foreshocks on 21st November 1939 near Terzhan/Turkey, and tremors were reported in England, San Jose, Manila, etc. (NYT, 22 December 1939). A quake with a force of 8 recorded on the Richter scale shook the Anatolia earth taking the life of about 35,000, injuring 100,000 and making several hundred thousand homeless. 90 villages and 15 cities over an area of 30,000 square kilometres were completely destroyed. The earthquake produced a tsunami wave of up to 3-4 metres, respectively of a one meter high wave crossing the eastern part of the Black Sea from the South to the North, as recorded in several Russian stations. What followed after the earthquakes were bitter cold, storms, heavy rains, floods and snow. It became a very hard period for the Turkish people. Most of their powerful neighbours were at war, while their government tried to manage the matter on its own. This massive earthquake occurred during the transition from autumn weather to winter. What were the weather conditions when the event happened? What was the contribution of this event to the extreme war winter 1939/40 in Europe? The arctic winter of 1939/40 was already well on its way in December. (A)

Further details: (A) Winter 1939/40, 2_11; North Sea cooling, 2_16.

Weather conditions before the earthquake

First indications that Central Europe had been ‘conquered’ by an anti-cyclone weather system, preventing milder maritime air from flowing through the middle of the continent, were available in the first half of December 1939 itself. Most significant deviation from the average weather became visible

just a week before the earthquake struck. Between 21st and 22nd, temperatures dropped to below minus 30°C in Finland north of the Arctic Circle. Around the same time (20th December), Northern Turkey had two high pressures of 1,040 mb attracting cold air from Siberia via the Caspian Sea. A low pressure (1,010 mb) shortly took control over Southern Turkey on 22nd, the high pressure returned again with two centres on 24th (ca. 1,040 mb), the pressure centre above 1,040 over the location of the epicentre on 25th, increasing to above 1,045 mb on 26th (02 hours), which increased over Eastern Anatolia to ca 1,050 mb during the early morning and presumably remained high until the earth trembled violently.



From 24th on, very low temperatures in Central and Northern Turkey accompanied the high pressures; (according to German and English weather charts). While it is up to geological scientists to say whether the high air pressure or the low temperatures could have influenced the earth quake timing, by hours or days, an immediate link to the arctic conditions in Finland's North. (A), seems difficult to establish. On the other hand, this investigation has shown that along the West Front (Maginot Line/Westwall) a lot of humidity had been taken out of the atmosphere, and the land corridor from Poland, Ukraine and eastwards may have been so dry, that cold air from the North-Eastern Depth (Siberia/Central Asia) could reach Turkey with little resistance (B)

Further details: (A) Russian-Finnish war, 2_41; (B) Rain-Making, 2_31.

It seems that in the affected area a high snow cover and severe cold prevailed prior to the quake, which contributed, presumably significantly, to the emerging catastrophe¹. Only a few days before the quake struck, on 21st

¹ Leuchs

December 1939, at least the Western Black Sea experienced a severe snowstorm with very unseasoned and deep freezing temperatures. (See below: Events). For a couple of days cold and very dry air came rushing in from the Far East. On the other hand, it seems that cold air did not travel very much beyond Turkey, at least it did not reach the Adriatic Sea. This actually occurred almost within hours after the quake.

What happened after the earthquake?

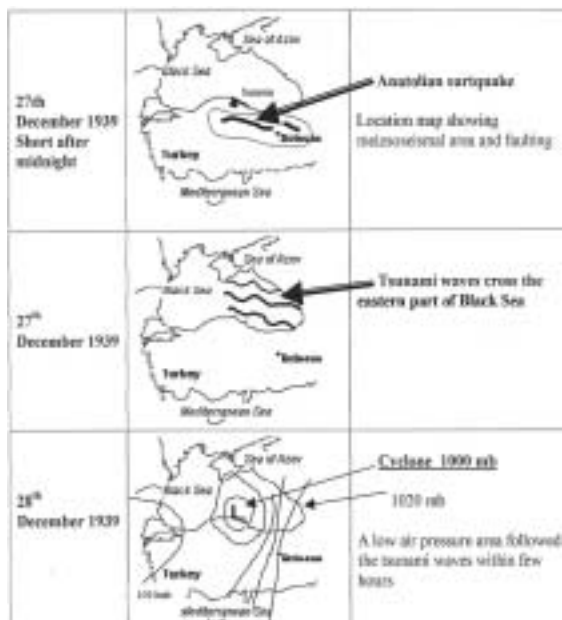
All information on the Anatolia quake for readers interested in news was published by the NYT. The New York Times did a marvellous reporting job under the prevailing difficult conditions. While the NYT even became almost philosophical in its comments on December 29, (see above) about geology, the meteorological impact of the quake is highly interesting for practical purposes as well. Did the quake and its meteorological side effects contribute to the emergence of the extremely cold war winter of 1939/40 in North Europe?

At the Turkish Black Sea coast, about 150 km away from the epicentre, the quake generated a strong tsunami wave of up to a metre height that crossed the eastern part of the Sea in less than one hour. It started with a retreat of

water seawards (by ebbs) of 50 metres and a flooding (of 20 m) of the land.² The wave reached a height of 50 centimetres at Sevastopol in 46 minutes and with a height of 53 cm at Novorossiysk in 27 minutes. The number of maximum waves was two for Sevastopol, one for Novorossiysk and ten for Yalta (max height 14 cm, running period 20 minutes).

It does not need much guessing that the tsunami waves

released enough 'energy' stored at sea surface to enable the formation of a forceful low pressure on the North coast of Turkey within hours of the quake.



² Dotsenko

³ Bernaerts, Black Sea

At a level of 20 to 40 metres below the surface, the Black Sea has in December still a substantial portion of the summer heat at hand (about half of the min/max. 7°C March, 12°C October), (source: by personal communication). Further its surface and deep-water bodies are of different hydro structure, the upper layer being rather thin and limited to about max. 100 -150 metres³, with certainly enough heat for an active cyclone towards the end of December.

At the time the earth quake struck, i.e. on the night of 27 December 1939 at 02 o'clock, there was a low pressure (995mb) over the Southern Ukraine, and another low pressure (1,005mb) at the Bulgarian/Greek/Turkish triangle, that moved south over the Aegean Sea during the next 24 hours. Meanwhile the low pressure over Ukraine moved into the southern Black Sea (off the city of Sinop/Turkey), halfway between Bulgaria and Georgia. The previous high-pressure centre was still in place ca. 600 kilometres away in Eastern Anatolia. At this short distance the air pressure difference of at least 35 mb, generated strong winds that brought hardship to Turkey with cold, wind, snow and floods. It would also certainly have contributed to the sudden cold and snow further west in Yugoslavia and Italy during the last days of the year. The low-pressure cyclone disappeared within the next 24 hours, while the high pressure over Eastern Anatolia stabilised (29 December) over a short period. On 31st December a number of low-pressure centres prevailed in the Black Sea area, (Aegean Sea, 1,000mb; Southern Black Sea, 1,005mb; Sea of Azov/Rostov, 1,000mb)⁴.

Recent research

Recently A.C. Yalciner⁵; “The Source Mechanism of 1939 Black Sea Tsunami” (2004), described the movement of the tsunami as follows:

The sea receded 50m, and then advanced 20m near Fatsa town. The sea also receded 50-60 m in Giresun, moreover in Ordu, the eyewitnesses at the harbor observed that the sea initially was calm, then receded about 15 m and returned to its original position in 5-10 minutes. The tsunami crossed the Black Sea and was recorded on tide-gauges in Soviet harbors with a height of 50 cm in Sevastopol and Novorossiysk, and 40 cm in Tuapse. The intensity of this tsunami can be considered as intensity III-V according to the new tsunami intensity scale of Papadopoulos and Imamura, 2001. Since the epicenter of the earthquake was far from the sea, the source mechanism of this tsunami is uncertain. The wave might have originated either directly

⁴ Seewarte

⁵ Yalciner

from rupture, or from the secondary fault in the Black sea, or from a submarine landslide triggered by the earthquake.

Summary

Taking into account events listed below, it is quite obvious that the quake on 27th December 1939 had a devastating meteorological effect for Turkey and the region, extending temporarily up to Italy. On the other hand, there is hardly any indication that the quake and the tsunami that were followed by a substantial low pressure in the Black Sea region had any influence on the Northern and Central European weather processing conditions. This part was clearly influenced by other forces that had already been prevalent when the Turkish quake occurred. But it should be noted that, at a very early time of the winter season plenty of cold air could travel easily from Asia to the south-western flank of Europe, which presumably contributed to the cold spell in the Danube river countries on 22nd December, although the cyclone (970mb) over the Gulf of Bothnia/ North Finland too could have assisted this event.

The tsunami of 27th December may have contributed, though in a small measure, to the wider regional conditions leading to the severe war winter of 1939/40. The freezing of the sea near Odessa in early January is within the average. Certain extreme situations (e.g. stormy conditions in late February) can be attributed to the unusual weather conditions in Central and Northern Europe during January and February 1940.

Chronicle

6 December 1939; Severe earthquake, probably in Central America. (NYT, 6 December 1939).

22 December 1939; Early morning hours; a low pressure (965mb) over the Gulf of Bothnia/ North Finland, and a high pressure over Western Rumania (1,035mb) control the weather in Northern and Central Europe⁶.

22 December 1939; A very severe snowstorm brought shipping in the Black Sea and lower Danube river to a standstill on Thursday (21 December). At the coast the temperatures dropped to 15°C below zero. The storm in Bucharest caused considerable damage. (Hamburger Anzeiger, 23/24 December 1939). Snow also fell all over Bulgaria on December 21-22, starting a new cold weather episode (down to -16°C); on December 24th in Northern Bulgaria -20°C; December 25th until the earth quake in Turkey on

⁶ Seewarte

⁷ Seewarte

27th more moderate temperature below zero, showing no specific weather anomalies, (according to the Bulgarian newspaper 'Zora'; by personal communication).

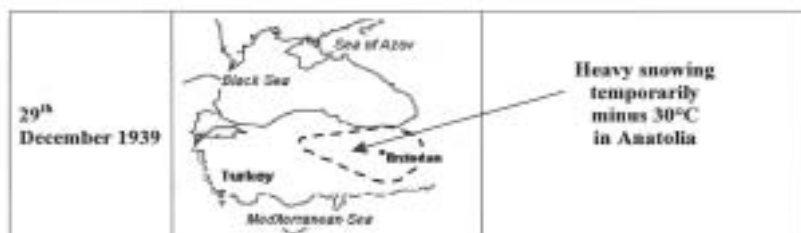
24-27 December; Baltic countries temperatures: In the Eastern parts of the Baltic countries (Russian West border) the temperatures fell to minus 17°C from 24th to 25th, and below 20°C one day later, extending to the Baltic coast, with minus 14°C in Klaipeda and minus 17°C in Gdynia (Bight) on 27th December 08-00 O'clock⁷.

28 December 1939; 6,000 die in Turkey as quakes are felt around the world. Successive aftershocks take heavy toll of life and property in Anatolia regions. Los Angeles Area shaken. Central America is affected – London seismograph broken due to severity of tremors. (NYT, 28 December 1939). "Three additional tremors, subzero weather (minus 17°C) and blizzard winds, .." - "Temperatures 22 degrees below zero (minus 30°C) and strong winds from the Black Sea claimed many victims..." (NYT, 29 December 1939).

28 December 1939; Tremors registered in California (116 miles south of Berkeley) South Africa, Italy. (NYT 29 December 1939).

28 December 1939; In New York record cold of 11.9° F; Four inches of snow reported in parts of State; Storms throughout the East. (NYT, 28 December 1939).

28 December 1939; Pope to visit the Italian King Victor Emmanuel today, for the first time since 1870, (NYT, 28 December 1939), see next: "28 December 1939".



28 December 1939; Rome. "A cold dreary rain did nothing to dim the brilliance of the ceremony that began shortly before 10 o'clock." - "to see the Pope at all in such a weather." (NYT, 29 December 1939).

29 December 1939; "10,000 soldiers with shovels, had cut through mountainous drifts of snow" - "The continued cold – as low as 22 degrees

below zero Fahrenheit – seemed to be the greatest threat.” (NYT, 30 December 1939).

29 December 1939; Temperatures in Turkey temporarily minus 30°C. Casualties in the Erzincan’s region about 42,000. (Neue Zürcher Zeitung, 29 December 1939).

29 December 1939; Ice closes Danube to German supplies; Rail traffic expected to be hampered by snow (NYT, 30 December 1939) “Cold winds have been blowing recently westwards from Russia, and the constantly low temperature in the river valley indicates a general freeze will set in soon.” (NYT, ditto).

29 December 1939; From Agram in Yugoslavia minus temperatures of 32°C are reported. (Neue Zürcher Zeitung, 31 December 1939).

30 December 1939; Turkey: New quakes add to toll in Turkey. Many more villages reported destroyed – Relief efforts hampered. Floods in West Anatolia. Erzincan’s casualties in quake at 42,000 – Allied and other Governments speed aid. (NYT, 31 December 1939).

30 December 1939; “In Naples region today an unprecedented severe snow storm...”. Rome’s heaviest snowfall in recorded history - six inches - made the Romans feel as New Yorkers did in the 1888 blizzard. There had been nothing closer to this since the snowfall for three days from December 16 to 18, 1846”. (NYT, 31 December 1939) .

30 December 1939; Cold wave over the Riviera. Genoa rapid fall of temperature, extensive snowstorm. Trieste reports heavy winter storms. Malians had –10°C. (Neue Zürcher Zeitung, 31 December 1939).

1 January 1940; “Turkish people suffered a third natural disaster today, following earthquake and floods, when terrific storms swept the Black Sea. Huge waves were dashing against Anatolian shores, and it was feared that many ships were floundered.” (NYT, 2 January 1940).

2 January 1940; Floods in Turkey affect quake relief. (NYT, 2 January 1940).

3 January 1940; More Turks killed as flood spreads. “Earthquakes, floods and bitter cold continue in many sections of Turkey.” - “The flood zone in European Turkey, near Adrianople, was still large but as rain moderated the rise was checked”. (NYT, 3 January 1940).

3 January 1940; New quake in Turkey levels ten villages. (NYT, 4 January 1940).

11 January 1940; Sea freezing near Odessa. Very low temperatures over the Black Sea. Rumania caught in minus 33°C, (according to the Bulgarian newspaper 'Zora'; by personal communication).

13 January 1940; The Balkan suffered from the effect of subnormal temperatures today with Northern Rumania the hardest hit, reporting eleven deaths by freezing. The temperatures fell to 25.6 degrees below zero Fahrenheit (-31.5°C) in Northern Rumania, and many villages in the Dobruja were snowbound. (NYT, 14 January 1940).

13 January 1940; Yugoslavia was the least affected of the Balkan countries, but at Belgrade heavy snow upset train schedules. (NYT, 14 January 1940).

13 January 1940; The mercury fell to 7.6 degrees below zero in Budapest (-22°C), but was rising. The Danube River, frozen over farther south, remained open here, but ice floes made navigation dangerous. (NYT, 14 January 1940).

Further climate conditions in late 1939:

- Concerning North and Central Europe, (Winter 1939-40, 2_11);
- Cyclones pushing south towards the Mediterranean Sea, (Violent weather, 2_52);
- Sea ice conditions in the North Sea, (North Sea cooling, 2_16);
- Weather and war conditions in Finland, (Russian-Finnish war, 2_41).

Mediterranean - Strange weather - winter 1939/40 (2_52)**Overview**

This paper is confined to listing certain significant weather events affecting the Mediterranean during the early winter of 1939/40 in support of the thesis that the arctic North European winter of 1939/40 was primarily caused by the war at sea in the North and Baltic Sea.

Actually, the war in the Mediterranean started only on May 11, 1940. It became aggressive and a devastating experience for all combatants as well as for many Mediterranean countries. The question whether the naval warfare in the waters between Europe and Africa in any way contributed to the downward move in global temperature since 1940 has attracted little interest until now.

This question is also of less interest for this thesis on climatic changes due to 'wars at sea' as the Mediterranean Sea has a very different feature from the North and Baltic Sea. While these seas could cause an arctic winter in Northern Europe, nothing like that would have happened as a result of a war at sea in the Mediterranean. The sea gets a lot of sunshine even during the winter and has a relatively warm water body. The homogenous water of the Mediterranean Sea with an average depth of 1536 m has temperatures of 12.8°C and 11.5°C at its deepest in the western basin of 3,719 m and 5,500 m in the Ionian Sea south of the Greek mainland respectively.

With such warm water body it is very doubtful whether the global cooling for four decades since 1940 was in any way connected with naval warfare in the Mediterranean from 1940 to 1943. Presumably, the opposite happened. Enormous naval activities most likely increased evaporation and thereby lessened the cooling trend, even though at a very low level. Due to its minimal relationship with the Atlantic Current System, the Mediterranean can definitely be excluded from being a serious contributor to a halt in the warming trend from 1940 to about 1980.

However, the naval warfare in Northern Europe 'created' abnormal winter weather conditions in south-western Europe, e.g. -12°C (close to Cap de Rosas/Golf of Lion) on December 24, 1940, while the whole of Southern France was down to about -6°C. The 'war weather case' in respect of the Mediterranean Sea still waits to be written. After all, the Mediterranean Sea may have contributed particularly during the winters of 1940/41 and 1941/42. Although the war at sea had not reached the Mediterranean Sea in 1939, the effect was felt, as the following list of events will show. The reason for this is that the war at sea in the North and Baltic Sea blocked the West Wind Drift,

which resulted in Atlantic cyclones being barred from travelling eastwards via Central Europe. The ‘blocked’ cyclones therefore had only two options, either to go north, or to move south. The path to the North is described in chapter: “Russian-Finnish war – December 1939”; and the path to the South in this paper.

What certainly played a decisive role in the weather in Mediterranean countries during the final days of the year 1939 was a major earthquake in Anatolia/Turkey on December 28. It is impossible to verify here as to from which date weather in the Mediterranean Sea was influenced by the ‘modification’ resulted by naval activities in the Atlantic or in the North and Baltic Sea. It could have happened as early as December 2 or 3, 1939, when Libya experienced a heavy rainfall, 25-litre/square metres, within 8 hours, brought about by a cyclone. (Source: Zeitschrift für angewandte Meteorologie, 57. Jg, Heft 8, p. 271.).

The report listed in the following two sections is not commented on any further. Details of weather-related events concerning the Turkish earthquake are available in the previous chapter.

Earth quake in Turkey and subsequent Black Sea cyclone

29 December 1939; From Agram in Yugoslavia minus temperature of 32°C is reported. (Neue Zürcher Zeitung, 31 December 1939).

30 December 1939; In all parts of Switzerland the lowest temperatures varying between minus 5°C (Locarno and Lugano) and minus 31°C (La Brevine) had been recorded in the most beautiful weather. In the Dolomites the temperature was minus 21°C yesterday. (Neue Zuercher Zeitung, 2 January 1940). Cold air blew from the East. (Neue Zürcher Zeitung, 14 January 1940).

30 December 1939; “Rome’s heaviest snowfall in recorded history -six inches-“. (NYT, 31 December 1939).

30 December 1939; “Naples region today reeled under an unprecedented severe snow storm which indirectly caused a train accident ...“. (NYT, 31 December 1939).

30 December 1939; Cold wave over the Riviera. In Genoa a rapid fall in temperature was followed by an extensive snowstorm. Trieste reports heavy winter storms. Milano had minus 10° Celsius during Saturday night. (Neue Zürcher Zeitung, 31 December 1939).

30 December 1939; Rome covered by 25-30 cm snow; Venice minus 5°C; severe cold in Yugoslavia with minus 23°C (Frankfurter Zeitung, 31 December 1939); cold wave in Bulgaria, the lowest at Rustschuk at the Danube river with minus 20°C. Banja Luka/Westbosnia minus 27°C; in Slovenian cities minus 26°C; Belgrade minus 18°C (Neue Zürcher Zeitung, 2 January 1940). The Danube River carries ice; and along the shores ice is building up; also in some bights at the Adriatic Sea icing has started. (ditto).

30 December 1939: "The cold wave that followed the snow has spread all over Italy. Ice floated down the Grand Canal in Venice and entered the lagoon, and Venetians feared that, if it kept up tonight, the whole lagoon would be frozen by tomorrow morning. " (NYT, 31 December 1939).

1 January 1940; Rome has not seen so much snow since 1846, although at that time snowfall lasted three days with a total of 22 cm; this time the snow lasted only eight hours at a temperature of minus four degrees Celsius. (Neue Zürcher Zeitung, 2 January 1940)

Atlantic diverts cyclones to the Mediterranean

1 January 1940; The Atlantic island Madeira reports heavy thunderstorm with heavy flooding. (Neue Zürcher Zeitung, 2 January 1940).

4 January 1940; Heavy rains during several days in Southern Spain caused severe flooding. Water in Guadalquivir River has risen by 15 metres. (Neue Zürcher Zeitung, 5 January 1940).

6 January 1940; Heavy flooding in Tajo river in Portugal. (Neue Zürcher Zeitung, 8 January 1940).

11 January 1940; In Northeast and Central Italy heavy storms with a wind speed up to 120 km from the West was reported, (Neue Zürcher Zeitung, 11 January 1940).

11 January 1940; Macedonia. Several people froze to death in Macedonia. (NYT, 12 January 1940).

11 January 1940; Greece. Storms lashed the Greek coast, driving the passenger vessel *Leon* ashore. (NYT, 12 January 1940).

13 January 1940; Rome. Reports of death, injury and extensive damage to property came from all over Italy today as a result of one of the worst storms in years, which in Rome disrupted telephone service. Thirteen persons were known to have been killed and three ships wrecked. (NYT, 14 January 1940).

13 January 1940; Temperatures fell in Portugal; Sierre de Estella reports 9°C below zero temperatures; and very unusual snowfall at Coimbra. (Neue Zürcher Zeitung, 14 January 1940).

14 January 1940; Snowstorms continued all over Spain preventing ships from leaving ports. The speed train from Valencia to Tarragona stranded in snow. (Neue Zürcher Zeitung, 14 January 1940).

15 January 1940; Heavy snowstorms all over Spain continue. (Neue Zürcher Zeitung, 15 January 1940).

18 January 1940; In the Navarro region a violent snowstorm rages; the road from Irun to Madrid is covered with 70 cm snow (Neue Zürcher Zeitung, 18 January 1940).

21 January 1940; In Paris (Porte de Lilas) minus 20 degrees Celsius; it is the severest winter since 1917 with 22 degrees below zero. (Neue Zürcher Zeitung, 22 January 1940).

23 January 1940; At Madrid it has been snowing continuously for the last few days. Snow cover was higher than in the winter of 1906. Never before has so much snow been recorded. At Bilbao the traffic was interrupted and work at the seaport stopped. (Neue Zürcher Zeitung, 25 January 1940).

25 January 1940; All over a number of Spanish provinces cold has doubled. In Madrid the temperature fell to -18°C; at Valladolid to -13°C. (Neue Zürcher Zeitung, 26 January 1940).

Months
later:



C. Three European winters: 1939-42

Occupation of Norway - Return of Ice Age (3_11)

Introduction

The Second World War (WWII) was in full swing from the North Cape to North Africa shores for 16 months when a second extreme cold winter exercised an icy grip over Northern Europe. Similar winters occurred during



three successive years during which an ‘arctic axis’ stretched from Stockholm to London. (A) The first war winter of 1939/40 and its evolution into an ‘ice age event’ in close conjunction with numerous relevant war activities at sea. (B), has been presented and discussed in: “Lost West Drift”. (C), and “North Sea cooling”. (D) This paper focuses attention on the second war winter of 1940/41 in Southern Norway, including Southwest Sweden and North Denmark, the land areas surrounding the Skagerrak.

The causation of the first arctic war winter 1939/40 as already presented in great detail in a number of other papers can also be fully applied to the second war winter 1940/41. But that would mean a lot of repetition. Therefore the Skagerrak area is focused.

Further details: (A) Cold axis, 3_22; (B) Sea and naval activities, 2_13, 2_14, 2_15; (C) Lost west wind drift, 2_12; (D) North Sea cooling (2_16.

Choosing Norway

Norway, in particular Southern Norway, is the only topic in respect of the second war winter of 1940/41. Sea areas deprived of sunshine easily provide a clue to whether weather modification had occurred. Norway’s coasts saw a lot of fighting in waters off its shores during the second half of 1940 since April.



Two Norwegian scientists, Th. Hesselberg and B.J. Birkeland, in 1956, concluded their study of variations in the climate of Norway from 1940-50. Even though investigating climatic variation over a period of 10-years, they devoted a small section to “The Three Cold winters 1940 – 42”. Evaluating this period on a mean value basis (three years), they

made only one exception in Table C, “The lowest Temperatures in January 1941”, for 65 stations in Norway. Table C indicates that the minimum temperatures in January 1941 were the coldest ones ever observed at these stations. With regard to Norway this means that the cold area was actually in Southern Norway only, and the record breaking cold centre had been close to the Oslo region¹.

Hesselberg and Birkeland’s paper points out that the cold temperatures in January and February had caused difficulties due to ice in February. A photo in the book with the caption ‘The ice conditions in Skagerrak, 2 km south of the lighthouse Lille Torungen on 25th January 1941’ shows outright polar conditions. How it looked in February is not photographed. But according to Danish ice observations, the whole Kattegat and western part of the Baltic Sea was frozen solid on 30th January 1941, but ice retreated immediately thereafter².

Choosing Norway to ‘represent’ the second arctic war winter of 1940/41 in Northern Europe aims at linking the war at sea activities with the harsh winter conditions there. While this has been done in great detail in respect of first war winter of 1939/40 (2_11), the second winter must do with much less details for the following three principal reasons:

- Only during the first war months were the seawater bodies and atmospheric conditions in the same status as reflected in the climate data records;
- The first ‘clash’ between the natural status and war activities may more readily show a ‘surprising’ or unexpected deviation from the average. An attempt to explain this was made in chapter “Cyclones and shells” (2_21);
- After 15 months at war, the extent and magnitude of warfare had become more difficult to summarize or to pinpoint in specific directions, although the war was still very closely bound to Europe’s realm.

But if precision work takes a long way for explaining, looking for the hammer may do, sometimes. The hammer in this case is the German invasion and occupation of Norway from April to June 1941 and the ongoing fighting in the seas along the Norwegian coast, from the Skagerrak to the North Cape. Only half a year later Norway, with a long tradition of weather observation, experienced temperatures never recorded before. After all, Norway has more than 2,000 km of coastline along



¹ Hesselberg & Birkeland ² Det Danske

the North Atlantic, and the warm Atlantic Gulf current flows along its entire western coastline. Suddenly Norway recorded its coldest temperatures since recording had started. A natural event was not in sight. A coincidence seems impossible.

On the other hand, restricting the assessment of the war impact to the Norwegian 'ice-age' conditions to the "hammer method" does not mean that this relationship can only be proved this way. On the contrary! One day that will be due. But as explained in the 'principal reasons' (above) this requires an even more analytical precision together with computer modelling. For the purpose of the current investigation, it is enough to provide convincing facts that a link between the arctic January 1941 weather in Norway and the war activities may (or must) exist. Alternatively, this 'coincidence' cannot be just brushed aside, but requires a convincing explanation.

The War at Sea during the Year 1940 and the "Weseruebung"

Conditions in general

In summer 1940 Germany invaded a number of countries, viz. Denmark, Norway, Benelux and France thereby getting access to ports and naval bases in Norway and France, with immediate or short distance access to the Atlantic. While the Baltic Sea had not been affected during 1940 the North Sea was an aggressive battleground. Rohwer³ recorded some 120 major activities involving several dozen naval ships and hundreds of bomber and fighter planes. While some of the events were recorded, other events such as the laying of the thousands of sea mines, the considerable number of ships which fell prey to sea mines, the thousands of depth charges that were dropped in the sea, or the hundreds of aerial bombardments, etc went unrecorded.

How tense the situation in the North Sea had been during the year can be well illustrated by a German mining operation at the Thames estuary from December 12-19, 1940. In a total of about 150 air plane missions, 300 sea mines were placed to which 12 ships, with together 20.675 tons, fell prey and sunk before years end⁴.

During the year 1940, naval activities moved more and more into the Atlantic and the Mediterranean Sea. In this respect it seems remarkable that continental high air pressure could take control over the Northern Atlantic from December 21-27. At least the North Sea was quite obviously not in a position to resist the advance of the continental air. Before that happened the North Sea saw a lot of fighting which included the invasion and occupation of Norway for two months. When Hitler ordered the invasion of Denmark and Norway in early April 1940, virtually the whole German Navy was

³ Rohwer

⁴ Rohwer

assembled for participation in the undertaking “Weseruebung”, also known as “Norwegian Campaign”.

Norwegian Campaign / “Weseruebung”

Rationale behind the Invasion: Germany was dependent up on ore from North Scandinavia for its war efforts. The way through the Baltic Sea or via Narvik Port only was vital for the German ore transport. In winter when the Baltic Sea was frozen, only the way over Narvik was open, which was either a very risky or required substantial naval escort. As early as in 1938 the import of 22 million tons of ore was needed. This required ca 5-7,000 ship movements either way per year or about 600 per month. When Hitler feared that the Allies would capture Narvik and the ore mines, the invasion started on April 9th, and ended on June 10th, 1940.

Invasion plan: The invasion was to take place from Oslo to Narvik in one move. A minimum of six locations were targeted, including the two cities already named, and Kristiansand (Skagerrak), Stavanger, Bergen, Trondheim, covering a distance about 2,000 km, with numerous fjords, bights, islands and rocks.



Naval encounter off Norwegian coast April 1940

Naval Forces: During the campaign until June 1940, presumably 80 to 120 naval vessels and ca.1,000 airplanes had been available in the service of the parties at war. Although the Norwegian Navy was small, it was able to lay sea mines with their fleet of a dozen mine layers and utilising installed coastal batteries at a number of locations. A well-known act by the Norwegian Navy is the sinking of the heavy cruiser *Blücher* with

old 28cm guns and torpedoes when she attempted to enter the Oslo fjord.

First battle: In the First Battle of Narvik on April 10th, 1940, five Royal Navy destroyers entered the harbour of Narvik where five destroyers of the

Kriegsmarine were seriously damaged, thereof two sunk. Six other German ships were also sunk. And also two British destroyers sank.

Support vessels: Material and ammunition needed by the German forces were to be transported to various locations by about 50 vessels, with a total capacity of 250,000 tons. Loss of ships and tonnage amounted to about 20% of the total available ships/tonnage including two tank ships of 6,000 tons during the campaign.

Military activities: The Number of activities or events really runs into many thousands. Rohwer⁵ has listed about 100 major events. The Allies, consisting of British, French and Polish personnel, were shipped in considerable numbers to Norway. Following the occupation of Narvik by German troops, 25,000 Allies soldiers were evacuated in early June. Three major encounters took place at Narvik and approaches (Vestfjorden) to the port on 10 – 13 April and on June 8 involving up to two dozen bigger naval vessels each time, with serious losses on both sides. The Campaign ended on June 10. During the struggle extending to two months a total of 34 naval vessels of about 500,000 tons including 9 submarines, 19 destroyers or bigger ships were sunk or damaged. The loss of naval vessels was equal on both sides.

Meteorological Situation – Northern Europe – 1940

General weather conditions

In Sweden the winter of 1939/40 was over by the end of March with lively cyclone activities and ample precipitation. End of April to mid June saw fine weather with no rain, followed by cyclone activities with plenty of rain in September. After some varying air pressures with the start of the next winter a mighty high pressure was established above Scandinavia which controlled the weather until the end of the year⁶.

Some striking features were observed in respect of the British Isles, e.g. January 1940 was probably the coldest in 100 years, followed by a very dull February with a very cold week. After that, it was warm with a few cold spells followed by a cool and showery July. August and early September were dominated by a cool moist weather after which the conditions were not far from the average until end of November⁷. The year can be summarized even more shortly by noting that the means at Greenwich for the whole year was below the 75 years' average⁸.

⁵ Rohwer

⁶ Statens

⁷ Gunton

⁸ Dines

In Germany the North and East showed a negative deviation of 1.4°C from the long-term annual average, the West and South only 0.9°C, due particularly to the cold January and February. Compared to months of August and September (North Germany only), October and December were 1-3°C colder than average. Only July and November showed positive anomalies. Precipitation was high in South and West Germany; in March, July, and September and November with 200% at times and in July even 300% above average. North Germany, particularly the Eastern part, was extremely dry in some cases⁹.

In summary it seems quite obvious that the war conditions ‘forced’ the autumn weather into a similar pattern as during the few war months in late 1939, creating continental conditions over Southern Scandinavia and Northern Germany. Due to activities in the North and Baltic Sea, during which the seas released more vapour than usual, the result was the penetration by north-easterly winds that pushed the humid air to more southern regions. As a further result, the ongoing war in southwest Europe (producing condensation nuclei) together with the southward pushing of heavier continental air forced the atmosphere to precipitate much more than normal. This situation is similar to that in autumn 1939 and therefore does not need to be repeated here.

Winter 1940/41

The conditions of the war winter of 1940/41 are easy to explain. Even though the winter was very cold it did not equal that of 1939/40 (Germany, Holland, Britain) or the third war winter of 1941/42, particularly in Sweden (A), Denmark and Holland. In Germany the winter of 1940/41 ranked 20 among about 150; in Holland it ranked 33 among about 150 ‘ice winters’ between 1706 and 1946¹⁰; and in Sweden it ranked 23 among the cold winters since 1757, the while winter of 1939/40 was in place 9 or 10¹¹. A reasonable explanation for the “mildness” of this winter (1940/41) is that the Baltic Sea was not used as a battle ground during 1940 and was left ‘undisturbed’ for some months. With the start of “Barbarossa” by invading Russia in June 1941 the Baltic Sea experienced its ultimate climatic drama, possibly the most spectacular regional weather modification experiment of all times. Concerning Northern Europe, during 1940, the North Sea had to bear main regional sea war activities, which had significant impact on the record cold temperatures in Norway.

Further details: (A) Stockholm’s record, 3_23.

⁹ Witterungsbericht

¹⁰ Labrijn

¹¹ Österman

Sweden, Denmark and Germany - winter 1940/41 weather

December 1940

Sweden, December 1940: During the first few days of the month a number of depressions moved in an easterly direction north of Scandinavia. On 5th a strong cyclone moved to Götaland (South Sweden) and strengthened there with plenty of rain all over the country. This was followed by a mighty anti-cyclone over Scandinavia for the rest of the month. Due to cyclonic activities in the north, the high pressure area temporarily moved south followed by the formation of a secondary low pressure over middle Sweden on 29th bringing plentiful snowfall to southern Norrland¹².

Denmark, December 1940: Frost that began just before the middle of



December caused icing, which started at the Northern coast of Lolland and a little bit later, among others, at some fjords in Eastern Jutland and in the Isefjord. No noticeable harm to shipping, however, was observed anywhere during this month¹³. Five light vessels in service in the Kattegat and Belts reported freezing temperatures on most days from December 12 until the end of the month¹⁴.

Germany, December 1940:

December was too cold and, with the exception of Northwest and Central Germany, too dry. Daily mean temperatures, except for December 3 – 10, were far too low with negative anomalies of about 1.5°C at the coastal regions and 5°C in the Dresden region. Frost and ice days had been 5-10 above average. There was a declining precipitation from west to east (100 – 200mm/20-30mm)¹⁵.

¹² Statens

¹³ Det Danske

¹⁴ Danish Light Vessels

¹⁵ Witterungsbericht

German Daily Weather Charts

December 1940¹⁶

2 December 1940; A chain of high pressure centres (1,030mb) stretched from the Azores to Ukraine, causing serious freezing temperatures in Madrid, Marseille, France (Paris -9°) and middle Europe.

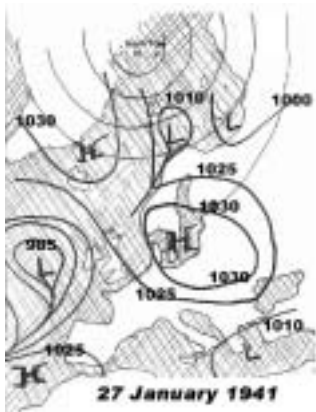
9 December; Europe under the influence of a low cyclone East of Ireland and a low-pressure area East of the Baltic countries. Anti cyclone in the West of Portugal.

15 December; High pressures (1,035mb) over Spain and Baltic countries, preventing Atlantic low pressure systems from reaching the continent.

21 December; A very mighty high pressure area (1,045mb) over South Norway (Oslo -17°, Copenhagen -11°, Hamburg -11°, Gdansk -1°, Helsinki -5°), covers the whole of Europe.

24 December; High pressure area (1,040mb) moved to the north of Scotland and stretched far north and the whole of Europe up to the Mediterranean shores.

26 December; While the high pressure area stretches from Central/SW Europe, Britain (centre with 1,035mb), Iceland to Greenland, a small cyclone (1,020mb) was active over the Skagerrak/Kattegat, another low pressure north of the North Cape (990mb) influenced the whole of Scandinavia.



--27 December; High-pressure centre (1,045mb) west of Britain (and over Rumania, 1,030); low pressure (985mb) over the White Sea (North Russia).

--28 December; The dominating high pressure area (1,035mb) moved to the Bay of Biscay, on 29 December to France, and 'disappeared' in the Mediterranean on 30th.

Correspondingly Northern Scandinavia and Finland were under a low pressure influence with a low pressure centre (995mb) over Stockholm; and on 30 December a low (1,000mb) lay in the Eastern North Sea and another

¹⁶ Seewarte

low (975mb) East of the Baltic countries. High pressure north of Iceland and in the Mediterranean.

31 December; High pressure prevails in the North (Greenland / Barents Sea) with a centre (1,010mb) north of Oslo (Oslo, -8°, Helsinki and Königsberg - 15°, Berlin +2°, Frankfurt +7°, Paris +6°), while a low (995mb) SW of Ireland moved south easterly.

January 1941

Sweden, January 1941: The month started with a high over Norrland that brought cold air from the Northeast to the southern and middle parts of the country, deepening continuously while moving in the direction of Svealand and Götaland to stay there, on the 6th pushing extreme cold air to these parts of the country. At the same time a mild westerly air current crossed Norrland in association with a low pressure that moved in easterly direction in the north of Scandinavia. The air pressure was high above the west and southwesterly Scandinavia and low in the East, whereby initially warmer air from NW and N moved to the middle and southern parts of the country. The period between 11th and 21st varied by an exchange of weak low and weak high pressure. On 13th/14th a cyclone with corresponding a precipitation area crossed from NW to the middle part of the country, while a high pressure was stationary over northerly Sweden with extreme cold in company. On 21st another high formed over Norrland, moving thereafter to the southern and central parts of the country to stay there until the end of the month, generating extreme cold, especially after 26th. Together with a cyclone in the south of Sweden the anti-cyclone caused a continuous sharp E-NE wind in Götaland from 21st to 24th, temporarily with plenty of snow in the southern parts of the country¹⁷.



In January 1941, southern and middle parts of Sweden had been colder than during January 1940, and in some locations colder than even 1860, when most of the meteorological stations in the country had been commissioned. The greatest heat deficit was observed in the inner parts of Götaland and northern Dalarna. Even in South Sweden severe night frost of -20°C and more was observed which, comparatively, is a very rare occurrence¹⁸.

¹⁷ Statens

¹⁸ Österman

¹⁹ Det Danske

Denmark, January 1941: Denmark recorded the coldest January since 1874. With regard to 'lower than average' water temperature or too cold water in the Skagerrak. Of particular interest is the fact that Northern Jutland recorded varying temperatures from -20 to -28°C , while Southern Jutland was about six degrees 'warmer', recording -16° to -22°C . January 1941 also served Denmark with the record temperature of -30.3°C ¹⁹, measured near Viborg station on January 29. It was the lowest temperature measured at the stations of the Danish Meteorological Institute. Until then the lowest temperature recorded was $-29,6^{\circ}\text{C}$, measured on January 17, 1893 in Holbaek²⁰.



All light vessels were withdrawn from service south of Copenhagen between 4th and 16th January due to ice formation and until the end of March except the vessel *Drogden*. *Drogden* reported from 1 January to 7 February 1940 permanent freezing temperatures, the lowest being -11.5°C (26 January) and -12.7°C (5 February)²¹.

Germany, January 1941: January was considerably too cold and, with the exception of large parts of Northern Germany, too wet. With the advance of a Nordic high-pressure area over Scandinavia at the start of the month, temperatures decreased $10-14^{\circ}\text{C}$ below average, which caused lively NE winds bring considerable snow. Around 6th the high moved to Scottish waters. A depression in the Barents Sea brought a mild warming to East Prussia and Silesia from 10-13 January. Thereafter two part-depressions formed, one along the Norwegian coast and the other in the Adriatic Sea, bringing more snow again, except to the Northwest of the Reich (Helgoland Bight). Subtropical air arrived via the English Channel with an Atlantic depression on 19th, with a strong thaw for a few days, until cold air from a Greenland high pressure area advanced to middle Europe, moving the frost line from the river Elbe into France generating $14-15^{\circ}\text{C}$ below usual means since 26th. A cyclone in the Channel region since 27th was not able to end the freezing period before month's end²².

Comment: Both Swedish and German meteorological analysis show clearly that the Atlantic 'weather kitchen' was working. However, the West Drift directed the cyclones eastwards either via the Barents Sea or south of the British Isles towards the Mediterranean. Particularly interesting is the low-pressure area coming down from Murmansk with warmer air for eastern Germany just before the middle of the month, while another cyclone arrived from the Adriatic Sea just a few days later. It demonstrates clearly that the

²⁰ Det Danske

²¹ Danish Light Vessels

²² Witterungsbericht

Baltic Sea still had some heat in store. All these together with the move of the initial high-pressure area to Scotland on 6th January demonstrated almost perfectly that the northern North Sea was ‘unusually’ cold, particularly the Skagerrak and Kattegat. This attracted and sustained arctic air conditions, forming the basis for producing record low temperatures in Southern Norway, and establishing the ‘glacial axis’ from Stockholm to London. After all, no January since meteorological observations were first recorded in 1860, had reached such low mean temperatures in northern Dalarna and Värmland and the inner Götaland²³. All of these regions are close to the Norwegian capital Oslo, which fact should not be ignored. Actually, average temperatures in January 1941 had been the lowest since 1914²⁴. But particularly the temperature data from Denmark strongly indicate that for the winter 1940/41 Skagerrak was the ‘cold bowl’ which stretched actually – as already mentioned – from Stockholm to London.

Norway – The Making of Record Temperatures

Monthly mean air temperature in Norway in January 1941



The last time Norway had uniform winter conditions from the North Cape to the Skagerrak presumably ended with the Ice Age. Its long coast bordering the North Atlantic and its coastal water hosting warm Gulf currents make it virtually impossible for stable winter conditions to prevail for two or three months, as is common in inner continental regions. The winter of 1940/41 proved it again. Conditions between North and South Norway were significantly different.

Generally speaking, the North was normal, while the South recorded great anomalies. While the North, north of Bergen, deviated in January 1941 from the average monthly means only by 1-3°C, the Southern region deviated toward the Atlantic coastal side by -5 to -9°C and in the Oslofjord and north of the Oslo region between -6 to -12°C from monthly means²⁵.

- Oslo/Blindern is recorded with -8.3°C;
- As, a few miles south of Oslo with -9.6°C;

²³ Statens

²⁴ Östermann

²⁵ Jahrbuch Norweg. Met. Inst

- Ferder at the entrance to the Oslofjord with -7°C ;
- Lyngor (between Ferder and Kristiansand) with -7.9°C , and
- Oksoy (near Kristiansand) with -7.3°C .

At the western coast close to Stavanger, what is particularly remarkable is the temperature deviation of -10.7°C at Sauda, a station in the interior of the Boknafjord, approximately 100 km inland from the open sea, while two other stations close to the sea, viz. Klepp and Skudenes, differed from the mean monthly average by -6.5°C and -4.9°C respectively.

*Lowest temperatures at a number of stations
in southern Norway – January 1941*

South-East region (Oslo), in: $^{\circ}\text{C}$. Source: Hesselberg & Birkeland

Roros, -47.5°	Lillehammer -27.1°	Eidsberge -29°	Brekke Sluse -30°	Kongsberg -31°
Rena, -36.2°	Modum -30.4°	Rade -34.6°	Freder -14.5°	Horten -20.8°

South-West region (Kristiansand – Stavanger), in: $^{\circ}\text{C}$.

Torungen, -19°	Kristiansand -21.5°	Lista -13.1°	Saudo -22.4°	Svandalsflona -23°
Tonstad, -26.6°	Skudenes -12.8°	Utsira -9.1°	Fjaerland -22.3°	Ullensvang -13.4°

As they were not very cold, the Atlantic coast stations are not included in the list of stations from Stavanger up to the North Cape covering record lows, although Narvik is listed with -18.9°C and some places in the mountains, eg. Nrodli (-36°C), Dividalen (-29.1°C), Karasjok (-46°C), and Karpbukt (-33.9°C) at the Varangafjorden (at the border to Russia).

Signals from sea water temperatures – difficulty to establish

From a climatic viewpoint it can prove disastrous to ‘stir and mix’ different temperate water levels, as this might have an immediate or long-term effect on the processes and the status of the atmosphere. Due to the complex sea water current system all along the Norwegian coast, it is extremely difficult to assess the available sea water data for their short-term impact.

Nevertheless, the next two sections will not refrain from attempting this in full realization that this does not meet with conventional research standards, but only aims to explain certain specific conditions in Norway’s coastal waters, which could significantly have contributed to the record temperatures. The following investigation seeks only to indicate that military activities had an impact on the sea water temperature structure. The section will assess the

situation at the Skagerrak south of Oslo. Thereafter data records on deep-water temperature measurements at four Norwegian stations are briefly explained and discussed.

Water temperature in the Skagerrak – Norwegian coast

As it has been shown that the Oslo region was the cold-centre between the North Sea, North Scandinavia, and the Baltic Sea, it seems reasonable to look at the Skagerrak for some clues as to why Oslo and not another place received the ‘cold hit’. For a more than 100 km wide zone along the coast from Oslo to the Lofoten (Narvik) there is no sea area as deep as the Skagerrak. Deeper water levels of the Skagerrak are possibly the most ‘unmoved’ of all deeper water bodies along the coast, at least on the basis of records of a few months.

Sea-surface temperatures taken by coastal stations are available in respect of the Northern Skagerrak. Seawards a very narrow coastal water strip between Ferder and Kristiansand, Skagerrak is 200 to 700 metres deep. Water is permanently cold below the level of 100-150 metres. A comparison between average water temperatures at two Skagerrak stations, viz. Ferder and Torungen Fry for the years 1935-39 and 1940 (June to December) will be made.

1937-1939 Sea surface water temperature – Ferder & Torungen Fry, in °C.

Station		May	June	July	Aug	Sept	Oct	Nov	Dec
Ferder	1939	10.7	14.7	16.9	19.4	17.5	10.3	6.5	3.0
	1938	9.2	13.2	17.2	19.4	15.5	12.3	9.4	5.5
	1937	11.2	14.7	19.0	20.2	15.8	12.1	8.4	2.6
Sum total		31.1	42.6	53.1	59.0	48.8	34.7	24.3	11.1
Mean total		10.4	14.2	17.7	19.6	16.3	11.6	8.1	3.7
Torungen Fry	1939	9.7	12.5	15.3	17.8	16.4	9.9	7.0	4.0
	1938	8.4	11.8	15.4	17.8	15.0	11.9	9.5	6.0
	1937	9.0	13.0	17.1	19.1	14.6	12.0	8.2	3.3
Sum total		27.1	37.3	47.8	54.7	46.0	33.8	24.7	13.3
Mean total		9.0	12.4	15.9	18.2	15.3	11.3	8.2	4.3

Station	May	June	July	Aug	Sept	Oct	Nov	Dec
Ferder								
Means *)	9.3	14.4	17.1	17.0	14.4	10.6	7.0	3.9
1937-39	10.4	14.2	17.7	19.6	16.3	11.6	8.1	3.7
1940	10.0	17.1	18.2	16.9	13.2	9.9	6.3	4.0
Torungen								
Means *)	8.2	12.7	15.4	15.7	13.7	10.5	7.1	4.4
1937-1939	9.0	12.4	15.9	18.2	15.3	11.3	8.2	4.3
1940	8.7	14.9	15.8	15.5	12.3	9.7	6.3	4.9
	Neutr.	warmer	neutral	colder	colder	colder	colder	Neutr.

*) Mean temperature 1871-30; Source: Frogner, Tables

The Table above indicates temperature fluctuations from August to November 1940. The water is already colder even before cold winter air covered the area. Almost two degrees of variation compared to corresponding periods of previous years is significant, indicating that military activities contributed to low temperature levels.

Since the invasion had ended in June, naval and aerial activities including the transport sector remained at high level along the coast. For more than one year the Kattegat, Skagerrak and Norway's coastal waters and fjords had been infested with thousands of mines laid by all parties to war; while mine sweepers were frequently or permanently operating to find and destroy enemy mines. In addition, presumably dozens, if not hundreds of depth charges were activated daily to hunt submarines or for protection from being targeted by enemy submarines.

Norwegian Directorate of Fisheries data series
(From 1935 –1943)

Only for a very short period the Directorate took water temperature measurements down to 300 metres at the following four stations during periods mentioned: Sognesjoen 1935-43 (near Bergen); Skrova 1937-43 and Eggum 1935-43, both at Vestfjorden, the approach to Narvik; and Ingöy, 1936-43 near the North Cape.



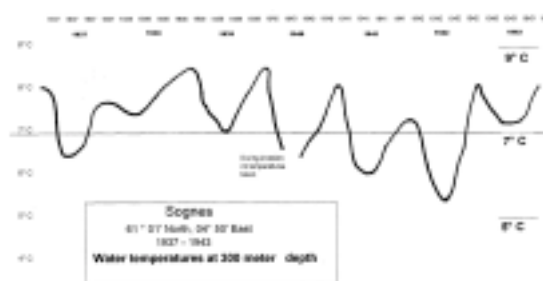
These short temperature series have been analysed by Frogner²⁶ in 1948, not only for formulating data tables for means during the observation period, but also for analysing the 'water situation' at those stations. He notes that the yearly periodic extremes are transmitted at Eggum and Ingöy fairly quickly from the surface to the bottom. At Eggum the minimum near the bottom (200 m

depth) is reached in the beginning of May. At both places the bottom water seems to originate partly from the sea outside, and is influenced only partly by vertical exchange.

Stations at Sognesjoen (Sögnnes) and Skrova have a more sheltered position than the other two and accordingly they show great difference in the vertical temperature distribution, whereby Sognesjøen seems to have a boundary level at about 100 m depth, and Skrova one at about 200 m depth. (ditto).

This investigation relied mainly on available data record of the deepest level (200/300m). Principal observations for three stations are briefly summarized as follows:

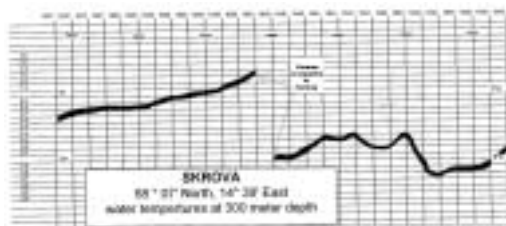
Ingöy (300m): The seasonal variation is high ($\sim 2^{\circ}\text{C}$), whereby the highest drop seemed to have occurred from about October 1939 until June 1940 by ca. 3°C , as against the usual 2°C . The deepest mark was reached in June 1941. There was a 1°C lower period, which lasted from about June 1940 to 1943. Whether the first drop in winter 1939/40 is in any way related to the Finnish-Russian war is impossible to answer here, although a number of naval activities took place in proximity of the North Cape at that time. Since December 1940 at the latest, quite a lot of activities had taken place in the very North from the North Cape to Murmansk. The second drop during



winter 1940/41 could well have its origin in military activities in the Norwegian Sea or along the coast of Norway.

Records at the stations Eggum (200 m) and Sögnés (300 m), show a very small negative

deviation from about June 1940 to June 1942. For Eggum this is hardly traceable. For Sögnés (temperatures had not been taken from April to July 1940) a significant low level was reached in June 1942. For three summers, i.e. 1940-42, temperatures were lower than average, while a significant positive jump (ca. 2°C , from 1942 level) occurred in 1943.



Most significant data records for the thesis of this investigation are those from Skrova (300 m) ($68^{\circ}07'$ North, $14^{\circ}39'$ East). The

importance of this observation derives from the fact that the water at the depth of 300 m is almost totally unaffected by seasonal variations, at the most, 0.2°C . From January 1937 (6.8°C) until March 1940 (7.3°C), the temperatures increased. The recording of temperatures was stopped from 30 March to 22 June 1940. When the recording resumed, the temperatures had dropped by more than one degree to 6°C , followed by temperatures within a range of 6.4 to 5.7°C until the series ended.

The same situation can be observed at Skrova at 200 metre level. As Frogner²⁷ already observed, the seasonal vertical distribution did not reach the 200 m level, the temperature stayed steady in a range of 1°C. Between April and June 1940 also the 200 m level temperature saw a sharp drop of one degree. Again a similar drop occurred during the time of invasion, and the decrease continued, on an even level, until the series ended in 1943.

This very significant change clearly indicates the cause, viz. numerous military activities, particularly the three major events close to Narvik (see above). On the other hand, one can assume with certainty that this temperature change at depths of 300 m and 200 m will hardly reveal a traceable impact on the arctic record temperature in Oslo just half a year later. In the case of Skrova it may take much more than half a year. But there were thousands of other places along the Norwegian coast and inside of many fjords, particularly in the south of Norway and the Skagerrak, to stir and mix warm and cold water levels that eventually invited a powerful high pressure to take control over Scandinavia and the Northern North Sea from mid December 1940 and January 1941.



At least two conclusions can reasonably be drawn from the Skrova case. If warm bottom water is replaced by colder water, the replaced warm water must emerge on a higher level and subsequently

would 'warm up' the upper levels. If this happens within a short period of time, simultaneously at many places and many thousand times, the weather may alter its course or wreak 'havoc'.

Sea Ice Coverage

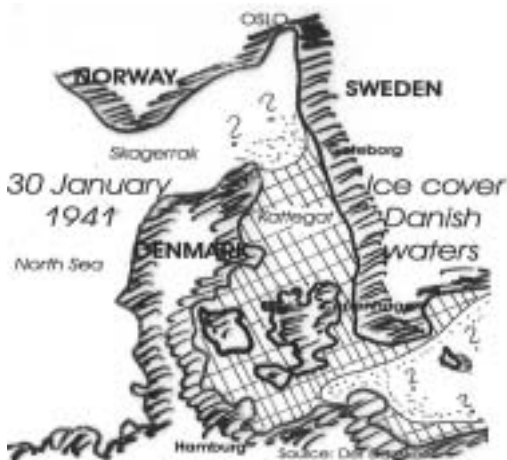
The Hesselberg paper²⁸ makes only one reference to heavy ice conditions in the Skagerrak with a photo. The photo shows ice conditions 2 kms south of Lille Torungen on 25th January 1941. That is a very significant information, but hardly enough to get a broader picture. Whether it will be possible to complete the picture one day remains to be seen. However, the appearance of so severe ice and at a fairly early time was an extraordinary event and can be

²⁸ Frogner

²⁹ Hesselberg & Birkeland

proved by looking across the Skagerrak at the ice conditions in Denmark's Kattegat. The formation of solid ice as such so suddenly can only happen after the sea water has been cooled out down to deeper levels and far below the average mean temperature.

Studied on the basis of the German coast on the North and Baltic Sea²⁹, the winter of 1940/41 ranks fourth among the most icy winters over a period of 45 years. During the whole winter period the ice production was about 25% less in 1940/41 than in the year before, the most extreme ice winter since 1903 until then. But also the next war winter of 1941/42 became a heavy ice winter, but remained, in respect of the Kattegat, less icy than the first two war winters. Therefore the discussion here will be confined to the first and second war winters.



A comparison of detailed ice charts prepared by the Danish Meteorological Institute³⁰ shows clearly that the extent of area covered by ice in 1939/40 was much larger and extended from the Kattegat to the Skagerrak. However, this happened only during the period from about 8th

February until the end of the month. In 1940/41, however, solid ice did not extend northwards beyond Skagen and the Kattegat.

What is remarkable here is that the formation of ice started about 14 days earlier than usual in 1940/41 and covered the whole Kattegat on 30 January, and reached its peak on 6th February 1941³¹. In the winter of 1940/41, at the Swedish West coast (Kattegat) ice formed two weeks earlier than expected³². However, in respect of the winter of 1939/40 the ice formation had occurred two weeks later than expected. One year earlier, in 1940, only one-half of the Kattegat had been frozen over by 2nd February. It should be further noted, that the high ranking of the winter 1940/41 in the list of heavy sea ice winters derives mainly from the extensive solid icing of the Kattegat.

³⁰ Nusser, Eisverhaeltnisse ³¹ Det Danske

³³ Östermann

³² Jurva & Palosuo

Summary on Norwegian water temperatures

Norwegian coastal sea water temperatures have to be seen in the wider perspective of the whole North Sea, including the Skagerrak and Kattegat. As the extreme sea water icing process started and quickly reached a maximum in the Oslo Fjord, the Skagerrak and Kattegat region. This provides a strong indication that extraordinary low water temperature conditions must have existed between Kiel, Copenhagen and Oslo. This should not come as too big a surprise. Since Germany had occupied Denmark and Norway, the German Navy was no longer interested in minefields in the Western Baltic, the Belts, the Kattegat and Skagerrak as far as the transport connection to Oslo and Norway was



Western Baltic Sea winter 1940/41

concerned and the Germans presumably swept many mine fields. In addition transport and naval communication had to be sound between Kiel and Oslo, requiring protective measures all the way.

All these activities must have caused a constant and considerable ‘stir, mix or turn-over’ of sea water from the surface to lower levels. Early and immediate solid ice coverage of the Kattegat strongly supports this assumption.

Analysis of sea water temperature data also supports this thesis. Military activities at sea, subsequent sea water conditions of the region and the following winter conditions can be reasonably linked together.

Conclusion

The ‘emergence and prevalence’ of the extreme cold winter of 1940/41 enabled this thesis to allege a connection between major climatic changes and war at sea, even though the winter of 1940/41 is by far not the most significant piece of evidence to prove this but is only a very helpful and interesting one.

Viewing from different perspectives, it can be safely assumed that military contribution, excessive rain, air circulation, movement of air pressure systems etc. might have had a direct bearing on the extraordinary conditions in the first war winter of 1939/40 in Northern Europe. In respect of the winter of 1940/41, it would be prudent to concentrate on only one major outcome of the winter, i.e. the extreme conditions at the Oslo region including the Skagerrak, SW Sweden, and Northern Denmark. Here the ‘sky opened’ and extreme cold air poured down en masse. This happens if a sea area is no longer in a position to ‘play its part in climatically defined terms of mean average conditions’, or in physical terms, the sea is no longer able to transmit enough energy in the form of vapour to the atmosphere. The North Sea, Skagerrak and Kattegat, had been transformed into such a situation in late 1940, presumably due to the war at sea.

Strongest support for this argument derives from the fact that Northern Scandinavia showed, according to principal meteorological criteria, that the weather was running close to normal conditions. The cold and deep waters of the Skagerrak were the principal cause to bring record cold temperatures to South Norway, Southwest Sweden and North Denmark. A comparable signal came from the eastern Baltic Sea area, where it was very cold but not extreme cold. At least, it seemed that the Baltic Sea clearly was not a major contributor to the harsh winter. The position was different in respect of the first and third war winters. It is therefore particularly important to note, that while the Baltic Sea was in principle left ‘undisturbed’ during 1940, it prevented Sweden (except for the inner regions close to Oslo; parts of Götaland and Dalarna) from being also dragged into the record-extreme conditions. That happened the next year (A), and possibly even much worse than Southern Norway had experienced.

Further details: (A) Stockholm record winter, 3_23.

The invasion of Norway was only a small fraction of the war activities at sea during 1940. But a major portion of all sea borne activities along Norway’s coast from April to December 1940 comprise those activities conducted in the whole North Sea over the same period. These activities, fully comparable with those during the first few months in late 1939, will have again dragged Northern Europe into an ice-age winter. Presumably, without the “Norwegian

Campaign” and the occupation of Denmark and Norway, and without ‘intensive’ use of the Kattegat, Skagerrak and other coastal waters of Norway, the Oslo region would surely have been spared of having record arctic cold conditions in January 1941.

Naval activities in the Baltic Sea 1941 (3_21)

A few words in advance on icing in the Baltic Sea

This study does not propose to elaborate on naval history. Many papers and books have appeared on this subject. Further, naval activities in the Baltic Sea during the second half of 1941 are reasonably well recorded. They tell



detailed stories on win and loss, strike and destruction, life and death, etc. But they reveal virtually nothing about what this fighting did to the sea body's temperature structure from bottom to surface. This has already been explained in respect of the Baltic Sea in a previous chapter. (A) While the sea is almost fully independent from the ocean system, and the Scandinavian mountain ridge lowers the free flow of air from the Atlantic into the Baltic rim, the Baltic Sea in autumn is like a bathtub filled with hot water. If one leaves the water alone, it will cool out itself; instead, if the water is stirred it will cool out more quickly. Naval activities produce the latter category of effect. If the temperature is lower in the Baltic Sea, the freezing of the sea will start earlier.

(B) Using the temperature and icing data available as a benchmark, this investigation tries to conclude that 'Barbarossa' caused an extreme winter in Sweden. Actually, Middle Europe from Stockholm, via Copenhagen, Rotterdam and London had been drawn back into the ice age. Presumably this is valid for the region between Riga and Moscow as well.

Further details: (A) Baltic cooling, 2_17; (B) Cold axis, 3_22)

To understand better the following list of some major, interesting or illustrative events, the freezing process as described by Palosuo in 1953¹ is reproduced below: "Freezing began earlier than usual in the northern part of the Bothnia Bay in the autumn of 1941. The shallow bays froze in the middle of October as a result of the first frosts, which started. But the freezing over was quite exceptionally early in the south, in the region of the Gulf of

¹ Palosuo, p.33.

Finland, during the following frost period, at the end of October when ice formed in the coastal bays. During the third frost period, which started in the middle of November, ice covered the inner archipelago of the Gulf of Finland. It was exceptional to have three successive periods of frost as early as this. A new and comparatively harsh period of frost began in the early part of December. In the middle of December the open sea of the Gulf of Finland, the area within view of the fixed observation stations along the coast as far west as Pellinki, was completely covered with ice.”

The early freezing in the Gulf of Finland is a clear sign that the mining, bombing, shelling and sinking of ships, etc did a considerable, effective and early cooling job.

‘Barbarossa’

The Deutsche Reich planned and commenced the invasion of the Soviet Union under the codename ‘Barbarossa’ on 22 June 1941 without declaring a formal war. With three million soldiers the German Army marched eastwards from the Baltic Sea to the Carpathians.



Flotilla in the Baltic Sea

The weather was fine for three months. Rain and mud dominated in the campaign from early October until the freezing took over from mid-November onwards. Weather conditions turned arctic by mid December that stopped any further advance and the conquest of Moscow. Any chance for Germany winning the war was lost under these icy conditions. This is not the occasion to speculate why the Red Army was better able to cope with these conditions, although it hardly comes as a surprise assuming that they had learnt from their devastating experience in Finland in December 1939. (A)

Further details: Russian –Finnish war 1939, 2_41.

Participants in the naval action in the Baltic Sea

The Germans mobilised about a hundred naval vessels; viz. 10 large mine layers, 28 torpedo boats, and 2-3 dozen minesweepers. Air support was entrusted to the Luftwaffe.

The Russians had six big war ships, 21 destroyers, 65 submarines, six mine layers, 48 torpedo cutters and 700 air planes.

The naval forces of Finland and Sweden were also present even though on a much lower level. The Finns working in loose cooperation with the Germans commanded possibly about a dozen smaller units that were able to assist in mine laying operations. During the first two months of the Barbarossa campaign they laid, along with German ships, about 5,000 mines and 3,500 sweeping obstacles². The Germans were able to use Helsinki as a naval base. The Swedish navy was not only involved in surveillance missions but also in laying mines. On a mine barrage that Sweden had laid at the request of the Germans, three German mine layers which were returning from mine laying missions in Finland ran into mines and sank on July 9th ³.

That Finland was actively involved in this mission is illustrated in the 'Finnish communiqué issued on December 7, 1941. (extract from NYT, 8 December 1941):

- Sea: Between Seivasto and Ino our coastal guns engaged in battle with an enemy fleet unit headed towards Kronstadt. An enemy battery at Yhinmaki participated. One enemy destroyer was hit. A snowstorm interrupted the battle.
- Karelian Isthmus: The enemy was active. Our artillery and trench mortars scored direct hits.
- Svir River Front: Our own artillery scored hits on artillery stations and trenches.
- East Front: In the north enemy attacks were repulsed. In the south,



after fierce fighting, our troops captured the town of Karhumaeki.

- Air: Our own air forces bombed military targets.

Mining of the Baltic

Mine warfare played an important role during the campaign 'Barbarossa'. Probably 20,000 or more mines were laid and many thousands swept and destroyed. Although many of the Russian mines were less than 100 kg, the

² Koburger

³ Rohwer

⁴ Koburger

The Soviet Baltic Sea Fleet alone laid 10,000 mines, by far the largest number in the Finnish Gulf and outside Soviet Ports in the Baltic, e.g. Riga and Reval⁴. In early August a dozen Russian naval vessels laid mines as far away as west of Bornholm⁵. Probably the last distant operation was a mining operation close to Gdansk from 20 October to 15 November⁶.

Reichsmarine made most intensive use of mines. They had laid a barrage with more than 1,000 mines from the mouth of the river Memel (Neman) to the island of Ödland/Sweden before the campaign Barbarossa had started. Another network of fields was later laid further west (Kolberg/ Bornholm)⁷.



The objective was twofold, to protect the vital commercial routes and to prevent the Baltic Fleet from operating. With this objective the mine-laying operations continued until November⁸.

The effectiveness of mines was high. The Russians lost almost 100 merchant vessels due to mines. One illustrative event occurred in early December when the Baltic Fleet desperately tried to evacuate the Finnish island of Hangoe. 7,500-tons *Josif Stalin* carrying ammunition and military personnel, during drifting, was hit by four mines that initiated a tremendous detonation, killing four thousand of the troops aboard. 2,000 men survived. Since the evacuation from Hangoe started on October 31 the Baltic fleet lost, in half a dozen missions, three destroyers, three fast minesweepers and other craft and

transporters *Josif Stalin*, *Andrey Zdanov*, the icebreaker *October* plus a host of smaller vessels⁹.



The effectiveness of mines was also demonstrated when the Baltic Fleet needed to evacuate their fleet bases at Reval. More than 200 ships had to be moved to Kronstadt. Over 4,000 mines lay on the way out, some of them laid so close together that the distance between individual mines was sometimes only 30 feet¹⁰. Once the convoys had passed minefields, the vessels were bombed or torpedoed. The move cost the

⁵ Rohwer

⁸ Rohwer

⁶ Rohwer

⁹ Koburger

⁷ Koburg

¹⁰ Woodward

Baltic Fleet over 50 naval ships and some 36 transporters and auxiliaries, the total loss of life was high, at least 6,000 men were lost.

Other naval activities

Rohwer¹¹ lists about 85 major naval activities including mining operations during the period from June to early December. Only a few can be cited here in general terms.

The Baltic fleet had 65 submarines of which only a few were in service. Nevertheless, they were a permanent threat to navigation and certainly initiated hundreds of attacks with depth charges. For example: on October



13th submarine SC-323 attacked the cruiser *Köln* off the Swedish coast, in vain, but later sinking the 3,724-ton steamer *Baltenland*¹². The Soviets lost 27 boats until the end of the year.

Coastal batteries were abundantly placed along all Baltic coastlines.

There is hardly any information available at what locations, how often and with how many shells they ‘penetrated’ the sea. At many locations, before the German army could set up a supply line, the place was fiercely defended by coastal batteries. In September the Baltic Island (e.g. Özel, Dagö, Mön) were still held by Soviet forces. It took quite some efforts by a flotilla of cruisers and aerial bombing to silence the coastal batteries¹³.

The involvement of bomber and fighter planes occurred frequently. The Baltic fleet had their own air force wing with about 700 planes, but no airfields left very soon. The Luftwaffe flew many missions but details are not easily available. Only significant hits are reported, e.g. a 1,000 kg bomb hit the battleship *Marat* at the pier of Kronstadt, destroying the front part of the ship¹⁴. The Luftwaffe flew 600 sorties against the Baltic Fleet in Kronstadt, either to sink the fleet or to drive them out of the port¹⁵.



Another occurrence must have required enormous protective measures, which quickly passed unnoticed. Suddenly all available German capital naval ships

¹¹ Rohwer

¹⁴ Rohwer

¹² Rohwer

¹⁵ Kronberger

¹³ Kronberger

navigated the Baltic during September, the *Tirpitz*, the pocket-battle vessel *Admiral Scheer*, the light cruisers *Köln*, *Nürnberg*, *Emden*, and *Leipzig*, etc. with a number the escorting destroyers. The flotilla moved as far north as the Åland islands¹⁶. When an invasion by the Baltic Fleet was no longer a threat to Sweden, the task force left the scene.

During these autumn months many merchant vessels were engaged in the transport of ore from Sweden and Chrome from Finland to Germany and of military goods to Finland on return.

Losses in the Baltic



While it is impossible to account for the full number of all explosive means adopted that ‘stirred and shook’ the Baltic sea, the drama that occurred in less than 6 six months might be illustrated by the loss of ships recorded. In very rough figures the total losses for the Baltic Fleet

were 120 naval and 90 non-military vessels; the Reichsmarine lost 35 ships and about 15 cargo ships (some to German mines); the Baltic countries lost 100 merchant vessels and together with Sweden and Finland about 15 naval vessels in total.

The total number of ships sunk in the Baltic Sea in the second half of 1941 is about 370 which may represent 500,000 tons.

The Southern Baltic Sea

The ‘Barbarossa’ campaign, as recorded and presented above, concerned the section north of the Memel – Ödland line. In the course of ‘Barbarossa’ only few mine fields were newly laid south and west of this line. No significant military encounters were reported from this sector. To this extent, this part was firm under German



¹⁶ Woodward

¹⁷ Liljequist, 1941/42

control. But while this was the case, presumably many mines laid earlier had now been swept. In addition to high naval traffic, exercises and training of personnel along the German coast, with the start of 'Barbarossa' a huge coastal transport operation also started from west to east to ensure continuous supplies to the army in the East.

Baltic Sea ice winter 1941/42

The Swedish meteorologist Gösta H. Liljequist¹⁷ wrote immediately after the extraordinary winter 1941/42 (excerpt):

"The winter 1941/42 was colder than the winters 1939/40 and 1940/41. At Stockholm it was one of the very coldest winters since 1756, when regular temperature observations were started. If we graduate the severity of a winter according to the value of the mean temperature of the three coldest months of the winter half year, 1941/42 is found to be the coldest winter since 1756.

The formation and breaking up of the ice took place at a rather normal time in the Gulf and Sea of Bothnia: The formation of ice in the Baltic and at the West-coast started in the first part of January, generally one or two weeks earlier than normally. The ice conditions grew worse after a mighty invasion of cold air on January 24th, when temperatures between -25° and -30° C were recorded in the whole country; at the same time the wind force was 6 Beaufort scale or more.

The thickness of ice was about 100 cm in the Gulf of Bothnia – the maximum value observed this winter being 125 cm – and 60 cm in the Sea of Bothnia. In the Baltic the values varied; between 50-60 cm were generally observed.

The ice period was generally longer than in 1939/40 but about the same as in 1940/41, except at the West-coast and in the Sound, where it lasted longer. On June 6th all Swedish waters were ice free".



Summary

Although the Baltic Fleet and the Reichsmarine never met face to face for a traditional sea-battle, 'Barbarossa' unleashed destructive force in the Baltic Sea, which this region had neither experienced at any time during World War I, nor during the two principal clashes two years before, when the Reichsmarine attacked Gdansk and the Baltic Fleet shelled and bombed Finnish islands and cities along the Gulf of Finland in December 1939. While the latter events had been able to make a significant contribution to the first war winter conditions, the third war winter owes its origin even more to anthropogenic reasons.

Winter weather – Cold axis 1941/42 (3_22)

Introduction

The Theme

The ice Age winter of 1941/42 is an important piece of evidence in the puzzle for proving that the war at sea during World War II was part of a force that changed the climate for decades. An immediate impact of the war at sea was the heavy modification of the winter weather in Northern Europe from 1939 to 1942. This paper focuses attention on naval activities in the Baltic Sea prior to the third war winter of 1941/42, particularly a few months after



Germany had attacked the Soviet Union over a 2,000 km battle line. For the campaign against the Soviet Union, the Germans allotted almost 150 divisions containing a total of about 3,000,000 men. Among these were 19 panzer divisions, and in total the “Barbarossa” force had about 3,000 tanks, 7,000 artillery pieces, and 2,500 aircraft.

The field experiment

Research in physics and chemistry often needs to reduce the parameters to laboratory size. Sometimes it would be better if the test could be done by a ‘field experiment’. For the emergence of the arctic winter of 1941/42, the Baltic Sea had served as the most perfect platform for a unique field experiment. Already the previous war winters of 1939/40 and 1940/41 had provided substantial proof of the interaction between the winter conditions in Northern Europe and the war. But in June 1941 the Germans attacked Russia, and thus Baltic Sea became a battleground until ice stopped the use of the sea. The invasion was called ‘Barbarossa’ and the Baltic Sea was part of the launching of the attack. A detailed paper will discuss this matter. (A) This section will present the general meteorological conditions up to the time the glacial winter took control in January 1942. However, after presenting a brief summary of the general weather conditions in some countries relevant to the subject during the year 1941, autumn and winter weather conditions will also be dealt with. The field experiment ‘Barbarossa’ was in full operation by then.



Further details: (A) Baltic battlefield, 3_21.

The weather during 1941

Germany

The year 1941 was throughout too cold and dull with high precipitation for the whole Reich. Actually, this applied more to the southern part of Germany, with 130-160% more rain northwest of the river Danube, the middle part of the river Elbe and Silesia. At the same time all coastal areas had good weather with above average parameters: 85-95% of precipitation, less cloud cover (2-5%), less dull days (2-10 days), and up to 200 hours more sunshine¹.

Comment: Fine coastal weather conditions during the summer can be due to extensive activities in the sea areas. Military activities and vessels navigating the sea kept the sea surface water cooler for some time. Water warmed by the summer sun increases the evaporation. Permanent mixing forces cold water up and warm water down. High precipitation in the Southern part of Germany may have had similar effects as in the previous two war years. (A)

Further details: (A) Rain-Making, 2_31.

Sweden

During the year 1941 cyclonic activities were of a lesser volume. They were of greater importance only during the months of August, October and December. That could be largely due to naval activities in the Baltic Sea. Stable high-pressure areas mainly determined the weather during all other months. This was the reason for the climate of that year to have a very unusual continental character, which was particularly pronounced in the southern and middle part of the country. January occurred to be the coldest month since 1860; precipitation was the lowest during April-May, and if taken together the lowest that ever occurred. In May the sunshine period in Stockholm was the longest since 1908 (when such record started to be taken). July was one of the warmest ever.

If it is reckoned that the months of October and December had been very stormy due to lively cyclonic activities, at least along the Baltic Sea coast, it has to be conceded from a purely meteorological point of view that the whole year was a very rich one in contrast².

Annual temperatures had been lower than usual (ditto). The biggest shortfall had been in northern Svealand and parts bordering Norrland with 1.5 -2°C. As January 1941 had been the coldest January month in Götaland and

¹ Witterungsbericht

² Statens

Svealand since regular recording had started in 1859, and July the warmest over the same time period, it had been the highest amplitude measured in this part of the country. The temperature was above usual the mean degrees in Stockholm (+11.5°C), Goeteborg (+11.3°C) and Falun (+14°C). The highest temperature measured in summer 1941 was in Lindhult (Skaraborgs lan) with 36.8°C on July 14th.



Troops near Leningrad early December 1941

Concerning the lowest temperatures of the year since the measurement had started, a new record for Sweden was noted. On December 13th (1941) on a plain alcohol thermometer at Malgoviks primary school, Laxbaecken, Vaesterbotton lan, (64 ° 37'

North, 16° 25' East) a very low temperature had been recorded. In comparison with a common thermometer this temperature was assumed as minus 53°C.

With regard to precipitation also the year was highly variant. In general, the precipitation had been too low and particularly the spring was very dry. Southern Sweden received excessive rain in August and in the first half of September, quite often, with heavy cloudburst with hail³.

Comment: As a Swedish weather analyst had remarked, it had indeed been a very contrast rich year. In general the same remarks apply for Germany also where the situation until May was certainly related to an ice rich winter. Concerning the 'warmest June' this could be due to relatively cold sea water, little maritime influence and plenty of sunshine. With regard to the active air movement in August, October and December, it could well be that the conditions of the Baltic Sea – together with military activities – provided substantial support by forcing warmer water from lower water layers upwards, thus supporting stormy conditions. Excessive rain in South Sweden in late summer is a



³ Statens

perfect demonstration of the thesis on the ‘stir effect’ due to war at sea activities resulting in increased evaporation presumably in combination with the ‘rain making’ activities, e.g. cloud seeding.

Britain

A cold January 1941 was followed by a snow rich February. In the NE district during the week commencing February 16th, new snowfall represented an equivalent rainfall of 744 per cent. The precipitation figure for the NE district in January and February was ca. 250%. Under the influence of northerly and north-easterly winds, the temperature remained below average (although not very markedly except for a mid-May frost) almost continuously until the third week in June, when a warm, dry, sunny period started, lasting for about four weeks. After this conditions again deteriorated, August being wet. Conditions improved at the end of August and the autumn was genial⁴. December was also regarded as mild⁵.

Comment: The notion of ‘genial autumn weather’ is a clear indication of continental influence, viz. higher air pressure situations than usual. A ‘wet’ August provides an excellent link to naval activities around the British Isles.

Autumn weather and the war in Russia

It is a well-known fact that the German Army within a few months of the invasion of Russia in June 1941 encountered winter conditions in Western Russia, the severity of which cannot be imagined. It was much out of tune with the climatic records over many years, and it is not surprising that the German armies had been badly prepared to face it. In so far they fell prey to a similar misjudgement, as did the Russian Army in Finland in December 1939. While the military offensive in Finland ‘pushed the weather’ to very cold temperatures under the Arctic Circle, (Russian – Finnish war, 2_41), the Germans drove the weather conditions ‘over the edge’ by turning the Baltic Sea ‘upside down’. Six months’ ‘treatment’ of the Baltic Sea in 1941 was several folds more intensive than in 1939, so also snow, freezing and ice conditions were severe along the whole German – Russian front line from west of Murmansk, Leningrad, Kalini, Mazhaisk (west of Moscow), Belowgrad, Rostov, and Sevastopol (Krim) a short time later. Since mid November 1941 the temperature during daytime was -3°C, at night it went down to -7°C. By the end of November the temperature fell to minus 25 degrees Celsius at the Eastern Front⁶. Along the frontlines close to Leningrad heavy snowfall blocked almost all German mechanized operations. (NYT, 04 December 1941). On December 7th the German High Command stated in a

⁴ Gunton, 1940/41

⁵ Gunton, 1941/42

⁶ Piekalkiewicz, p.527ff

communiqué, that “despite bitter cold, German and Italian troops have won successes in local offensive in the Donets Basin” (NYT, 08 December 1941), and that the winter forced abandonment of big operations in the north until spring. (NYT, 09 December 1941). In December temperatures were down to -40°C ⁷. However, the first war winter in Russia for the German Armies started in January 1942. The Battle of Moscow lasted until April 1942. More than 3 million people, up to 3 thousand tanks, more than 2 thousand planes and over 22 thousand guns and mortars were involved in the battle on both sides⁸.



Before the emergence of the severe cold at the Eastern Front, there was a very heavy ‘mud-period’ lasting from early October until freezing commenced. It started with snow at about October 7th and continued with rain, bearing quite a number of similarities with the situation

discussed in an earlier chapter concerning rain-making with regard to the Western Front along the river Rhine in late 1939. Until the end of December 1941, the invasion had cost the German Army: life of 174,000 men, 600,000 were wounded and 36,000 were missing. The material loss amounted to 758 bomber planes, 568 fighter planes, and 767 other types of air planes⁹. The loss of tanks, flaks and vehicles was immense; losses of the Russians were often considerably higher by irrecoverable losses of 3.000.000 men, plus 1,3 million wounded and sick¹⁰.

While there is plenty of the material available on battles, air strikes, tank attacks and infantry actions, reliable meteorological studies are rare and difficult to find. This investigation was also not able to find and present data from the Baltic countries. This is admitted with regret. As this region as well as Western Russia experienced a winter 1941/42 not seen in many decades, possibly in more than a century, it should definitely have been included in this paper which actually applies for the first three WWII winters.

Fortunately, to prove the argument of the thesis ‘climate change by war at sea’, any in-depth knowledge of the situation east of the Baltic Sea is not needed. The knowledge that it was killing cold and the weather conditions with climatic records were out of tune is sufficient enough. In order to demonstrate the solidity of the thesis, reliance on the extraordinary winter

⁷ Piekalkiewicz, p.535, 569ff ⁸ (www.russiancourier.com) ⁹ Piekalkiewicz, p.535
¹⁰ (www.russiancourier.com)

conditions in Sweden and elsewhere in Northern Europe and available climate data records will provide enough information.

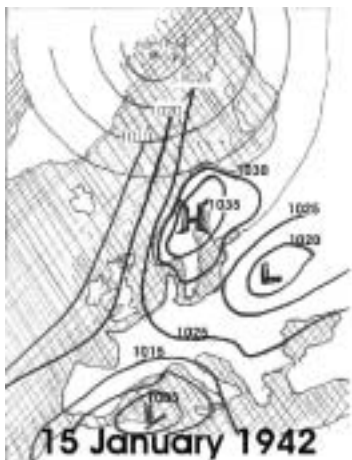
Winter months of 1941/42

*Germany*¹¹

October: The stable European weather changed suddenly when an extensive low-pressure area from the Barents Sea intensified over the Baltic Sea on 9th October, and at the same time an Atlantic cyclone approached the German North Sea coast. The weather remained varying while a Mediterranean cyclone controlled Central Europe on 29th October.

November: Variant weather continued well into November, whereby the North Sea coast saw some warming due to a virulent cyclone off Norway (on November 5th), which could withstand the influence of an Atlantic high air pressure area. From thereon a north-easterly weather situation prevailed with interruptions.

December: December weather was too mild and, except for larger areas in south Germany, too wet. On December 3rd a warming period started in North Germany with a mix of snow and rain. The weather remained very variable, with a number of cyclones passing northerly Europe, bringing subtropical warm air, and moving the temperatures 8-10°C above average. A cold front of a South-Swedish cyclone ended the impact of the subtropical warm air, while precipitation in North Germany continued until an Atlantic high-pressure area brought clear weather. The weather changed suddenly with the inflow of arctic cold air causing abundant snow with clear frost days until the end of the year, except for North Germany that experienced some moderate temperatures due to a warm front, causing thick fog.



January 1942: At the start of the month strong frost continued east of the Wisla (Weichsel) only, while a high-pressure area over France brought mild maritime air with rain for the rest of Middle Europe, coming down as snow in East Germany. With a strong rise of the air pressure over the Atlantic cold arctic air flooded in, building up a high-pressure

¹¹ Witterungsbericht

area in the North, driving cold air from Russia far to the West (January 8/9). From January 14th to the end of the month several new thrusts drove in continental air, while disturbances moved from England, via France to the Mediterranean. The temperatures dropped everywhere - except over the 'Ostfriesischen Inseln' (North Sea islands) – to minus 20°C, followed by absolute record freezing temperatures on January 22nd - 23rd.

Comment: The situation in late 1941 and January 1942 demonstrates that the North Sea and Baltic Sea, as in the previous war winters, had been too 'weak' to ensure Atlantic West Wind to function as usual, i.e. to stop the advance of continental air to its shores. Particularly the move of cyclones south of England and straight to the Mediterranean indicates that the Atlantic weather machinery was functioning. The developments since January 14th show that the Baltic Sea suffered a 'breakdown', unable to emit any heat into the air that would at least have minimized the free flow of arctic air straight into Europe.

Netherlands

The winter 1941/42 (rank 3) was colder than 1939/40 (Rank 8) during the period of observation from 1706 to 1946¹².

*Sweden*¹³

October: A number of cyclones brought a lively variation to weather conditions with gale winds and rain particularly over the southern part of the country. A high-pressure area, arriving from the west drove hard northerly winds along the whole East coast. A low pressure over Norrland brought some mild westerly air and on its backside cold air up to gale forces in the Bottenhavet and the northern Baltic. On October 28th a strong cyclone arrived from NW over South Götaland and caused north-easterly snowstorms at the West coast.

November: The weather remained variable with strong winds or gale, along the whole Götaland coast from 12th – 14th. Particularly severe was the gale in Skane, south and east coast (Trelleborg, Karlskrona), with wind forces about 11 Beaufort on 13th. From 16th – 22nd high air pressure prevailed with permanent foggy and misty weather in South Sweden. Cyclonic activities continued briefly from 26th – 29th in the North, returning to a dominant high pressure on the 30th.

December: From the 6th to the end of the month, with a few exceptions, the weather was dominated by passing cyclones sometimes in opposite wind

¹² Labrijn

¹³ Statens

directions (Norrland – easterly; Götaland –westerly), enormous weather variations and a ‘deep fall’ of temperature, up to 15 degrees in 24 hours. On December 27th to 28th wind-forces 10 and 11 Beaufort were registered at the West- and South coast.

January 1942: After a brief interruption by a small cyclone crossing southern Norrland, a very high air pressure centre established over northern Scandinavia by January 13th and remained there until the end of the month, rising to levels never registered before. Temperatures fell to record lows, and under cloud covered skies easterly winds reached –25° to –30°C on January 24th. (A)

Further details: (A) Stockholm’s record, 3_23.

Sweden	Location	January 1942			February 1942		
		average Jan. 1942	Normal 1901-30	Lowest 1942	average Feb. 1942	Normal 1901-30	Lowest 1942
	Kiruna	-16,6	-11,9	-35,5	-15,8	-11,8	-33,4
	Haparanda	-17,0	-10,3	-31	-14,2	-11,2	-30
	Umeå	-17,2	-7,4	-30	-13	-7,4	-27,8
	Östersund	-16,9	-7,9	-31,4	-11,2	-6,8	-26,4
	Karlstad	-12,3	-3,2	-25,2	-10,8	-3,1	-24,6
	Stockholm	-10,6	-2,5	-28,2	-10,5	-2,6	-18,8
	Karlshamn	-8,4	-0,3	-22,5	-6,6	-0,6	-16
	Malmö	-7,5	+0,3	-25	-6,2	-0,2	-20

All figures in minus Celsius degrees; source: Statens

Comment: The enormous variation and erratic behaviour of the weather is a significant indication that the ‘underlying’ seas irritated the atmosphere and forced it to unusual behaviour. Also the Swedish picture shows that the making of the Atlantic cyclone was still functioning in December, but that the continental air thrust through Middle Europe finally prevailed.

The relatively warm December (see also Denmark) might find its explanation in two factors: a lot of warm surface water had been ‘plugged under’ in summer and early autumn, while in December naval activities and busy sea transport forced cold surface water down and warmer water to the surface.

Denmark

The winter 1941-42 was extraordinarily long lasting and cold in spite of a December having mean temperatures above normal. January and February were about 6°C colder than normal for the country. From January 7th on, a long and lasting frosty period started, and temperature dropped to a record low of –31.0°C on January 26th. After a severe cold in February (max.

- 29°C), also March and April had been cold, with considerable frost on April 4th (-17°) and again considerable frost during April 25th to 29th.¹⁴

The winter of 1941/42 was of a quite unusual character, long lasting and cold. Considering the 'amount of cold', this winter took the first rank with a cold-sum figure of 497.5, whereas the winter 1939/40 as the number two only reached the figure 368.5.¹⁵

Finland

The Finnish sea ice specialist Palosuo made the following assessment for December 1941 and January 1942¹⁶ – excerpt - : A new and comparatively hard period of frost began in the early part of December. December 20-22 the weather was milder, with a variable, mostly W-wind. On December 23 frost increased and a new period of hard frost set in. Wind was weak. Hard frost set in four days later on 27th, with very hard frost in the central part of the Gulf of Finland. On the following day the weather became a little milder and it began to snow, and after a couple of days mild weather set in, i.e. in the evening of December 31, the wind shifted to South and increased to 3-5 Beaufort. On January 6 a strong outbreak of arctic air mass began to push outwards from the north southward over Finland, resulting in the formation of a ridge of stationary high air pressure over Scandinavia. By January 15 the outbreak of cold air had reached Germany, where the independent cold air pool ("Kaltlufttropfen") was formed. Thus the period of severe frost had begun.

Britain

The weather during September to November 1941 had been 'genial' (see above). December was mild. The year 1942 began with a cold spell which lasted until mid-March and which included the coldest February in England and Wales since 1895. Frosts, however, were not very intense and the normal daily temperatures were reached on a few occasions. March was a month with some extraordinary variations in temperature

In January 1942 deviations from the mean value, on a 7-day basis, were as follows: Scotland N. (-2.5 to -5.1); Scotland E. (-2.5 to -5.7); England N.E. (-2.5 to -10.3); England E. (-2.7 to -10.1); Midlands (-2.7 to -10.1); Scotland W. (-3.3 to -5.9); England S.W. and N.Wales (-3.9 to -8.1); Channel Isles (-2, -2.9, +0.9, -0.8)¹⁷. January was also very dull, cold, and a great snowstorm affected much of Britain on 19th.

¹⁴ Det Danske

15 Det Danske

18 Greenwich

16 Palosuo

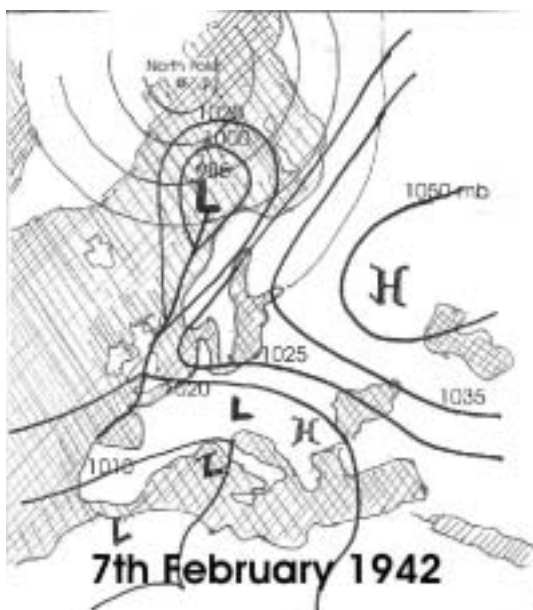
17 Gunton

With regard to severity, the winter was more severe in the SE. At Greenwich the January means had been 33.5°F (5.6°F below the average for 100 years, 1841-1940); the February mean had been 32.2°F (7.6°F below average)¹⁸.

At Kew Observatory Drummond observed, that “perhaps the most outstanding feature of the 1941-42 temperature curve was the failure of the mean February 1942 temperature to rise to the average on any single day¹⁹, and together with the January temperature did not reach the average for 56 days. This shows that the North Sea was “exhausted”, the summer heat had gone.

Comment: The report confirms that the war at sea around the British Isles had strongly supported the basic conditions for this winter of 1941/42. Severe, dull and extraordinary variations indicate strongly a war at sea relevance. A corresponding situation, with unusual cold winters and snow conditions also happened during World War I between 1915 and 1918. That Britain did not fall prey to absolute record winter conditions can be explained with increased naval activities in the North Atlantic.

Cold Air Pool January 1942



The paper by E. Palosuo²⁰ presents an extract from Richard Scherhag: “Neue Methoden der Wetteranalyse und Wetterprognose”, Berlin 1948; which is repeated below:

“An arctic air mass, in the form of a closed upper low, had already advanced over Europe earlier. It had reached Finland on January 8th, and on the 15th divided over Germany where one fork was driven to the North Sea on the southwest flank of a Scandinavian high

¹⁹ Drummond

²⁰ Palosuo, p.37

pressure, while another fork was caught by a central-Russian low pressure and remained there. On January 18 a smaller, independent cold air pool was formed over north-west Germany, while the Russian dome, considerably reinforced on the arrival of another cold trough penetrating from the north-west, again reached out over Germany from across the Baltic. In a few days, however, it was pushed back eastward with the main mass. There it united with a low pushing westward from the interior of Siberia. This low reached the district of Moscow on January 23rd, and on the day after the atmospheric space around Smolensk; (on the 25th) it was still perceptible above the Baltic Sea.

This surface low was accompanied, in the free atmosphere, by unusually low temperatures and a corresponding upper cyclone. When, the night before, it passed Riga the lowest temperatures measured to date above the European atmospheric space were recorded in several layers....It may be mentioned further that the average temperature of the 1,000-500 mb layer was lower than that corresponding to the January average at the cold pole, which best illustrates the unusual intensity of this cold air pool”.

Comment: The analysis clearly illustrates that the Baltic Sea played a role in the establishment of winter weather. Getting the ‘cold pole’ so far south and in the Baltic region would not have occurred without the war fought in that region. Experiment accomplished.

Summary and further subject chapters

The principal aim of this investigation was to outline prevailing extreme weather conditions to prove the validity of the thesis, that the war at sea changed the climate in the last century. The third war winter of 1941-42 is a particularly visible example to reiterate that the fighting in the Baltic Sea had led

to the extreme temperature and weather conditions. Although the North Sea must be regarded as a main contributor to the harsh winter conditions of



1941/42 from Stockholm to London, as also in the previous two war winters, the impact of the war at sea can sufficiently be proved by the situation in the Baltic Sea in late 1941 alone. To provide evidential circumstances comprehensively the relevant topics are elaborately discussed in other connected chapters covering the following themes:

- Naval activities in the Baltic Sea – June-December 1941 (3_21); page 173.
- Stockholm's arctic winter 1942, Sweden's record conditions – Swedish weather analysis - Winter 1941/42 (3_23); page 193.
- Three year ice package, Europe's war winters 1939-1942 – The three year-winter-package (3_31), page 199.

This chapter could show how strongly the weather deviated from normal, and that the 'erratic' weather coincided perfectly with time and actions of the war. Many of the events mentioned can be considered either on an individual basis or together with other events, as massive circumstantial evidence to prove that five months of war in the Baltic waters heavily modified the course of the winter weather conditions of 1941/42.



Submarine bombed

Stockholm's arctic winter of 1942 (3_23)

Choosing Stockholm

This paper presents an example of the extraordinary winter conditions in a number of places along the 'cold axis' stretching from Stockholm to London during the three arctic war winters of 1939-42. (A) As a representative example Stockholm is chosen to study these conditions. On the one hand the weather observation at Stockholm was properly done during war times, and the resultant data was analysed comprehensively by eminent Swedish meteorologist Goesta H. Liljequist (see below). On the other hand, Stockholm was close to the enormous activities in the Baltic Sea from June 1941 until December 1941 connected with the invasion of Russia by Germany, when sea icing halted naval warfare at sea. (B) To this extent, Stockholm was not only one of the top freezing cities along the 'cold-axis', but was bound to take the trophy for the ultimate top freezing winter. (C)

Further details: (A) Three war winters, 3_31; (B) Barbarossa, 3_21; War winter 1941/42, 3_22.

The following elaborations seek to show that this event did not come about as



a 'natural variation', not even a little bit. Like the previous two war winters of 1939/40 and 1940/41 the winter 1941/42 was also caused by the war at sea in the waters of Northern Europe. However, with regard to Stockholm, the appearance of the war winter 1941/42 is a massive evidence

showing that waging a six months naval warfare in the Baltic Sea inevitably catapulted Stockholm into a record cold even beyond the conditions experienced in the Little Ice Age.

Sweden already out of tune in 1941

Sweden experienced a very variant year with a number of extremes. As elsewhere in north-western Europe the winter of 1940/41 was very cold. The summer 1941 was generally warm. In Stockholm the temperature was +11.5°C above the usual mean. The highest temperature measured in Sweden in summer 1941 was 36.8°C on July 14th (at Lindhult, Skaraborgs lan). With regard to precipitation also the year was highly variant. In general they were too low, particularly the spring was very dry. Southern Sweden received excessive rain in August and in the first half of September, quite often with heavy cloudburst and hail¹.

December 1941 also remained variant. From 6th to the end of the month with two exceptions, the weather was dominated by passing cyclones sometimes with opposite wind directions (Norrländ – easterly; Götaland – westerly), enormous weather variations and ‘a deep fall’ in temperature of up to 15



degrees in 24 hours. On 27/28 December wind-forces 10 and 11 Beaufort were registered at the West- and South coast.

Another extraordinary event was a temperature drop in the middle between Narvik and Stockholm before the year 1941 ended. On

December 13th on a plain alcohol thermometer at Malgoviks primary school, Laxbäcken, Västerbotten lan, (64 ° 37' North, 16° 25' East) a very low temperature was recorded. Based on the comparison with a common thermometer it could be assumed that a temperature of minus 53°C was registered. According to the Swedish Meteorological Service² it was a new record for Sweden.

¹ Statens

² Statens

The Swedish winter 1941/42 in detail

Amazement of a scientific witness

Goesta Liljequist expressed his amazement about the winter 1941/42 as follows: After the two hard winters of 1939/40 and 1940/41 and the difficulties they generated for the shipping and the fuel supply for the country, one has awaited and expected that the winter of 1941/42 would bring a return of the mild winters, which had recently predominated. Instead this winter became one of the toughest, if not the severest of all winters during the last 200 years³.

January 1942

General Overview: During the first few days of the month a moderate westerly airflow dominated. On 4th a high pressure zone developed in the NW of Lappland, which brought cold winds to the whole of the country. On 7th a small low pressure area moved over Norrland to the East, where the air pressure remained equally distributed but afterwards increased in general. On 13th there was a high-pressure zone over the northerly Scandinavia. Wind came from an easterly direction in most parts of the country until the end of the month. The highest air pressure of 1,045 mb was measured on 21st in Norrland. Together with the easterly winds snowfall occurred temporarily, particularly on the Baltic coast. On 24th very cold air came from the East, despite a cloudy sky, the temperatures dropped down to -25°C and to -30°C, with a wind speed of more than 10 m/sec at the same time. On 26th temperatures recorded were between -35°C and -40°C with a clear sky and calm as far south as Smaland. Especially, between the days 25-26 and 29-30 a great difference in air pressure was recorded between northerly Sweden and southerly Baltic Sea, with easterly winds (kultje) dominating temporarily at the Baltic Sea.

Air pressure: The mean value was higher as usual all over the country. The deviation in the northerly Norrland was the highest (17-18 mb), but decreased gradually towards the south, so that at Skane the deviation was still 4-5 mb. Never before had such a high January mean air pressure been recorded for Norrland. Usually the air pressure in Norrland is lower than in Götaland. Westerly and south-westerly winds usually dominate then. In January 1942 the situation was completely reversed, which caused permanent easterly or north-easterly winds.

Temperatures: The biggest temperature deficit – about -10°C - was recorded in the interior parts of Götaland, northern Varmeland, Dalarna and southern Norrland. A number of record temperatures were recorded in Götaland and

³ Liljequist, 1941/42

⁴ Statens

Svealand. The temperatures were 6 to 7°C lower than the lowest known temperatures until then⁴.

A depiction of the circumstances evidently demonstrates that the Baltic Sea (and North Sea) had lost their usual heat reserve.

The following table shows the deviation in January 1942 against the mean monthly January temperatures, and in comparison with the values of 1880, the previous 'severe winter' (on about place ten of the severe winters since 1757 at Stockholm, see below).

Location	Means monthly Temperatures		Highest and lowest Temperatures			
	Period 1901-30	January 1942	1880	1942	1880	1942
Harnsand	-5.8	-14.7	+10.0	+3.0	-35	-27
Stockholm	-2.5	-10.6	+10.5	+2.8	-23	-28.2
Joenkoeping	-1.5	-11.2	+10.5	+4.0	-25.3	-33
Göteborg	0.0	-8.9	+9	+4.8	-24	-26
Karlshamn	-0.3	-8.4	+11	+4	-20.5	-27

February 1942

Wind and snow restrained the navigation and rail traffic. The difficulties reached their height in Skane on 12th. On 15-16 with mild winds temperatures returned to positive figures in North Sweden, while there was a severe cold in South Sweden.

The air pressure had been higher than usual over the whole country. Deviation 9-10mb in Norrland; in Skane 4 mb.

The temperatures had been lower than in February 1940 at a number of locations.

Location	Means monthly temperatures		Highest and lowest Temperatures			
	Period 1901-30	February 1942	1880	1942	1880	1942
Harnsand	- 5.3	-11.7	+12.5	+0.2	-32	-26
Stockholm	-2.6	-10.5	+9.3	-0.2	-24.5	-18.8
Joenkoeping	-1.7	-11.3	+12.2	-0.4	-31	-33.3
Göteborg	-0.3	-7.9	+9	+1.0	-25	-19
Karlshamn	-0.6	-6.6	+13	+1.0	-24	-16

Source: Statens, Arsbok Vol.24

It is worth noting the remarkable difference of highest temperature values in 1880 compared with 1942, which demonstration again, that the Baltic Sea was deprived of the common seasonal heat reserve in January and February 1942.

March 1942

In the southern Götaland and Gotland Island it was the coldest March since 1860⁵. The sea ice conditions in Swedish coastal waters were severe and long lasting.

Considerations

The following factors seem to be particularly interesting:

- The fact that the deviation from the lowest mean temperature was significantly severe in the middle and southern parts of Sweden.
- The ‘highest monthly temperatures’ were far lower than in 1880. The difference of 7°C in January, and 10°C in February (see tables above), is a clear indication that the Baltic Sea had ‘cooled out’ very early so that the sea could hardly supply the atmosphere with any energy.
- The high air pressure in Norrland is certainly worth noting as well as the change of position with Götaland with regard to higher/lower air pressure.

Stockholm's ice winter 1941/42

In 1943 Goesta Liljequist made a thorough assessment of the “The severity of the winters at Stockholm 1757 – 1942”. The following data have been gathered from his work.⁶

The winter 1941/42 ranks high in the list of very severe winters. Under a group of 15 most severe winters since 1757, the winter of 1939/40 ranks about 10, and the winter 1941/42 in the top ranking as follows:

No	Mean temp. of Dec. – March	Mean temp. of the three coldest months	Sum of negative monthly means temp.
1	1788/89, -8.0°	1941/42, -9.2°	1788/89, -31.9°
2	1808/09, -7.6°	1788/89, -9.1°	1808/09, -30.5°
3	1941/42, -7.5°	1808/09, -8.7°	1941/42, -30.5°

Liljequist points to the fact that since temperature observations were taken about 1760 the mean winter temperatures had increased by about 2°C and that this tendency was especially well marked from the middle of the 19th century. Insofar the deviation from ‘normal’ became even more evident.

⁵ Liljequist, 1941/42

⁶ Liljequist, Severity

It should be noted that the ranking of winters on the basis of the ‘three coldest months’ is a clear indication that the heat reservoir of the Baltic Sea had diminished to the lowest level. A general assessment of the summer and autumn weather conditions (see above) does not necessarily indicate that a ‘break-down’ of the Baltic’s heat reservoir was in progress. This should not come as a surprise. Massive ‘stirring’ of huge water areas over the autumn months by naval activities presumably supplied plenty of humidity that gave the impression of a sort of ‘normality’. At the same time the water quickly lost a lot of stored summer heat. This is particularly confirmed by the fact that since February 15-16, North Sweden moved to some positive temperature gains, but a severe cold continued in South Sweden. The latter aspect points to the fact, similar to the winter of 1939/40, that the Baltic Sea was a front player in bringing about the harsh winter.

Conclusion

The place of the winter of 1941/42 deep in the time of the Little Ice Age is remarkable. It is even more remarkable given that a global warming was evident for many decades. The winter of 1941/42 was for this reason more outstanding than the two other top ranking winters about 150 years earlier.

The reasons are anthropogenic. The military combat between the German and Russian naval forces (A), in the Baltic Sea for over five months in autumn 1941, shifted the course of the Baltic climate and gave Stockholm a record arctic winter.



Further details: Barbarossa, Baltic battlefield, 3_21.

When the Baltic Sea saw a cease of naval warfare due to heavy sea icing the war went global. Japan attacked the United States on Hawaii on 7 December 1941. The impact of the attack can certainly not be measured in climate statistics, as it was only the prelude for intense naval warfare in all oceans and seas for four years.

Three year ice package, 1939-1942 (3_31)

From highest warmth to lowest cold

The last decade before WWII was the warmest period since meteorology had started recording around the globe in the 18th century. To this extent, the weather had been gaining strength since the Little Ice Age, which ended around the middle of the 19th century. Since then global temperatures had risen steadily. Even the eruption of the Krakatoa volcano in Indonesia on August 27, 1883, whose dust clouds spread around the globe and blocked solar radiation by up to 20% for three years¹, had no significant effect on the weather and the climate. At least, no occurrences of record weather conditions had been reported from anywhere.



About half a century after the Krakatoa eruption, the weather played havoc in Europe during the winters of 1939-42. Suddenly, there were three arctic winters that could be included in the league of the coldest winters during the Little Ice Age one hundred years ago. There were no major volcano eruptions, no earthquakes, no sunspots, nor did a big meteorite fall to the earth anywhere. Only a war had been started in Europe in September 1939. Suddenly, 'a force' emanated which needed the shortest period of time to take Europe back to the Little Ice Age. What an enormous energy and dust cover released by the Krakatoa over a period of three years could not achieve, namely a significant modification of regional or global weather, occurred in Europe, out of the blue, within a quarter of a year after the war had started. European winters turned from mild to arctic. Each of the triple war winters (1939-42) is discussed elsewhere in detail.



Two 'war at sea' phases during WWII

A further strong indication of the enormous impact the Second World War (WWII) had on weather modification and climate change can be found if one reviews the first three war years, and their corresponding winters of 1939/40, 1940/41 and 1941/42, as a 'package'.

¹ Wexler, Effects

For two and a half years, from September 1939 until spring 1942, the war at sea had been largely confined to Europe's seas or close-by waters. Most of the military activities took place in the Baltic Sea, the North Sea, the Eastern part of the North Atlantic and the Mediterranean Sea. This changed completely within a few months after Japan's attack on Pearl Harbour on December 7th, 1941, and when the United States joined the Allies as a party in war against Japan and Germany. The picture of the war at sea changed dramatically, when it became global and entire areas of the North Atlantic and North Pacific became major battlegrounds. The war machinery increased to dimensions anyone could have hardly imagined prior to the Pearl Harbour event. The global war at sea from 1942 to 1945 is discussed in chapters: 'Oceans at war', and 'Ocean system affected'. The focus of attention in the following is on the time period when the war at sea was mainly confined to European waters.

Climatic relevance of the two phases

Before looking at the European 'three war winter package', brief considerations should be given to the presumed relevance or difference that each phase may have had on the significant climate change that started with the winter of 1939/40. So far it is widely accepted that global temperatures reflect a significant cold phase from 1940 until the end of the 1970's. Any immediate impression that this trend was caused by only one event may lead to a wrong conclusion. The war at sea from 1939-45 had two distinct periods: the regional war at sea in Europe (1939-42), and the global war at sea (1942-45).

With regard to ocean structures and dynamics, a war at sea confined to European waters is an event that differs from the turmoil caused by the 'stirring and mixing' of entire ocean areas for more than three years continuously. Actually since 1942, all seas in the Northern



Hemisphere, from Murmansk to Florida and from the Bering Sea to Manila, had been 'ploughed through' in combat by many thousands of ships, torpedoes, bombs, depth charges and sea mines.

The most obvious practical impact of the extended war at sea since 1942 was that the global war at sea impeded further severe war winters in Europe. This does not mean that the 'war impact' on Northern European waters had been diminished, but that the global sea water 'stir and mix' effect superseded the regional impact (e.g. to early cooling of regional sea water).

From a logical point of view, one might expect that if all military activities had been stopped in December 1941, the climate would have quickly recovered to pre-war conditions. In this case, the three severe war winters from 1939-42 could have been regarded as 'modified' by the war at sea.

However, as recent precedents to the 1939/42 events indicate, that logic would lead to a wrong conclusion. As will be shown in other chapters, the specific warming in the Northern Atlantic realm in the 1920's and 1930's had most likely been caused by the war at sea during 1st World War (WWI). (A) Insofar, one could expect the 1920's-1930's warming trend to continue, if not to increase.

Further details: (A) Spitsbergen heats up, 5_12.

As the war at sea had not been terminated in December 1941 but went global instead, the trend changed to cooling, thus indicating that it makes sense to clearly distinguish between pre and post Pearl Harbour with regard to weather modifications and climatic changes.

War and the seasons

The relevance of annual seasons and geographical regions has been repeatedly emphasised in other papers. Making any distinction is to select those periods most suitable for climate change research. In Northern Europe there are seasons when the daily influence of the sun is reduced and is thus weak. During winter the ocean and seas become the most direct, if not the sole 'weather generator'. An impact of the war machinery on the sea is easier to trace in the absence of the otherwise dominating climatic factor, the sun.

In summer a war at sea will generate the same 'alterations' to the hydrodynamics of the seas (although sometimes with totally different consequences), but it will be much more difficult to identify changes in the behaviour of the weather, though the relevance is obvious. From the moment the sun is in a position to warm the sea surface, any 'stirring and mixing' by military activities will force the warm surface water into depths. Once energy is stored in water, it will remain there for quite a while. Even this process may show a climatic effect during the summer season, as briefly explained in the next section.

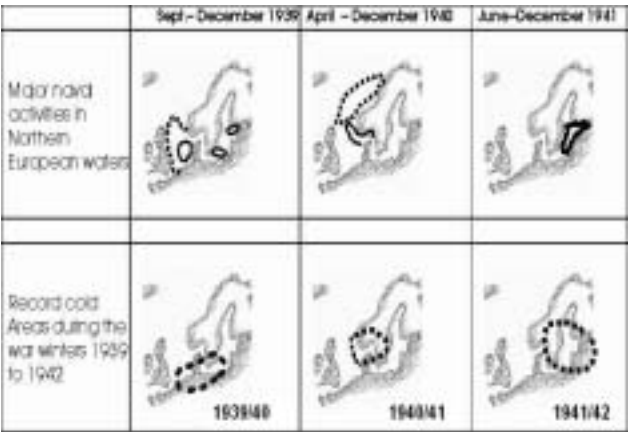
Three war summer: 1940 -1942

In countries close to the North Sea and Baltic Sea, the three war summers were generally regarded as fine, sunny and dry. After cold winters, this has not happened for the first time. The cold water of the seas gives the area a more continental impact with more sun and subsequently more warm and summery weather. By war-at-sea-activities the period of cold surface water may have been prolonged, and thus extended the continental weather period beyond normal.

Centres of record winters

It is interesting to observe that certain regions reported record climatic events on the one hand and on the other hand had seen intensive military activities ‘close by’.

1939/40: Germany reported a record cold winter. In fact heavy mining, fighting (e.g. Gdansk), military surveillance, transport and exercises took



place in the coastal waters of the Baltic Sea during pre-winter months.

1940/41: Norway claimed to have recorded

low temperatures as never measured before at a number of stations in

southern Norway

immediately after the Germans had invaded Norway in the summer, and mine warfare and fighting continued along its coast, and heavy ship movements took place between Germany and Norway thereafter.

1941/42: Sweden and Stockholm claimed the coldest winter in more than 130 years, after the German invasion of Russia, codenamed ‘Barbarossa’, brought heavy fighting to the Baltic countries from June to December.

The centre of the cold was ‘in the middle of the Baltic and North Sea’ somewhere between Hamburg and Skagen. Not only Sweden claimed the third winter of 1941/42 as the coldest, but also Denmark² and The Netherlands³, leaving the first war winter 1939/40 ‘only’ a second place.

² Det Danske

³ Labriijn

Scientists' observations of war winters 1939-1942

The occurrence of three very severe winters in succession during WWII, can be regarded as a major evidence to prove that this was not a natural variation, but was caused by massive military activities in Northern European waters. Before discussing this matter further, the exceptionality of these winters shall be discussed with reference to remarks of scientists, who are 'contemporary witnesses' and whose work had been published already during WWII, or soon after these remarkable winters.

Drummond 1943 – Kew Observatory

Drummond⁴ started his essay on data from Kew Observatory with the following text: "The present century has been marked by such a widespread tendency towards mild winters that the 'old-fashioned winters', of which one had heard so much, seemed to have gone for ever. The sudden arrival at the end of 1939 of what was to be the beginning of a series of cold winters was therefore all the more surprising. Never since the winters of 1878/79, 1879/80 and 1880/81 have there been in succession three so severe winters as those of 1939/40, 1940/41 and 1941/42." He further points to another significant aspect with regard to the theme of this investigation: "Since comparable records began in 1871, the only other three successive winters as snowy as the recent ones were those during the last war, namely 1915/16, 1916/17 and 1917/18, when snow fell on 23%, 48% and 23% of the days, respectively". Drummond's table showing the percentage of days of snowfall is as follows:

Year	December	January	February	Dec.- Feb. Means
1939 -40	6	32	24	21
1940-41	6	36	29	23
1941 -42	3	42	46	30
Average(1871– 1938)	6	10	11	9

Comment: The snow issue is a marvellous piece of evidence to link war at sea and weather modification.

Lewis 1943 – British Isles

Lewis⁵ made the following two statements concerning the snow-cover in the British Isles in January and February of the severe winters of 1940, 1941 and 1942. "The three consecutive winters of 1940, 1941 and 1942 were, however, unusually severe; the snow was



⁴ Drummond

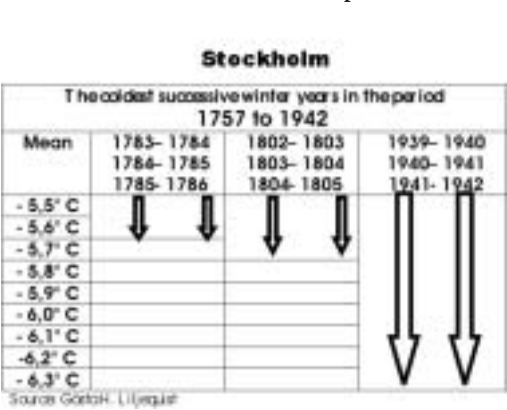
⁵ Lewis.

⁶ Liljequist, Stockholm

considerable and the number of days of snow-laying comparatively large”. “Three such severe winters in succession as 1940, 1941 and 1942 appear to be without precedent in the British Isles for at least 60 years, a similar succession occurring from 1879-1881.”

Liljequist 1943 – Stockholm

Liljequist⁶ writes: Very cold winters in Sweden occur as a rule under circumstances when the atmospheric circulation is weakly developed, but



they are sometimes intensified due to eruptions of cold air from the Arctic. Three consecutive cold winters are scarce. During the period 1757-1942 only three such cases occurred (means temperature of December – March lower than minus 5° C); for which the figures are shown.

Comment: The result is remarkable. Not only is 1939-42 clearly the coldest

group of three winters, but also the difference to the next coldest group is astonishing. While the difference between the other two record groups is 0.1 C° the difference between 1802-05 and 1939-42 is 0.6° C.

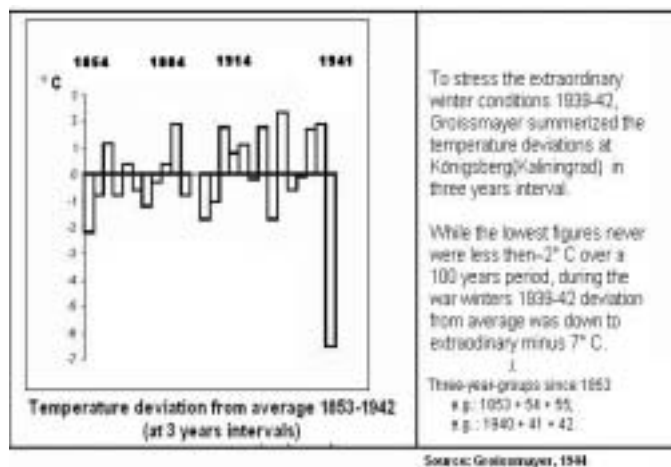
Liljequist summarizes his results on Stockholm’s cold winters from 1757-1942 as follows (excerpt): Since the beginning of temperature observations from about 1760 up to the decade 1931-1940 mean temperatures of the winter have increased by about 2° C. This tendency is especially marked from the middle of the 19th century. The number of severe winters has decreased in recent years, while mild winters have remained rather constant in number.

Liljequist concludes his summary (excerpt): The remarkable change in the winter climate came to an abrupt end in 1940, with three severe winters 1940, 1941 and 1942. It is noticeable that one of the very mildest series of three winters, viz. 1938-1939 preceded the most severe ones, 1940-1942.

Comment: War at sea in general, and the cold winters of 1939/40 and 1941/42 in particular, the extensive fighting in the Baltic Sea and the Gulf of Finland provide the only plausible explanation for the severity of the war winters of 1939-42 in Sweden.

F.B. Groissmayer⁷

As early as in the war year 1944, Groissmeyer summarized temperature data according to three year intervals starting in 1853 until the third war winter 1941/42. The result is shown in the corresponding graph.



Hesselberg and Birkeland 1956 - Norway

Authors Hesselberg & Birkeland⁸ give a number of information on the particular speciality of the three war winters. With regard to the most exceptional winter of 1940/41 in respect of Norway, the winter that followed the German occupation of the country in summer 1940 is outlined in greater detail in chapter: Occupation of Norway (page 153). Most remarkable is the fact that only South Norway actually experienced three severe winters due to its closeness to the North and Baltic Sea which was one of the main areas of war

at sea activity. According to the authors, who provide only departure figures from the corresponding mean values for the period 1901-30, some figures concerning Southern Norway (in approximation) are given as follows:

The means deviations for the period 1940-42 from the mean values for the period 1901-30:

Approximate figures for Southern Norway (Source: Hesselberg)

	Winter	Spring	Summer	Autumn
Atmospheric pressure	+6 mb	+3 mbar	+0,5 mbar	+0,5 mbar
Air temperature	-4°C	-1°C	$+0,3^{\circ}\text{C}$	$+0,2^{\circ}\text{C}$
Amount of precipitation	- 12%	- 8%	+2%	+3%
Wind from the north	+24%	+8%	+4%	+7%
Wind from the east	-5%	0	0	-2%
Wind from the south	-17%	-10%	-6%	-9%
Wind from the west	-1%	+2%	+2%	+4%

Comment: The change in wind directions from the south to the north is quite remarkable. It indicates an enormous flow of air towards the North Sea and

⁷ Groissmeyer, 1944

⁸ Hesselberg, Birkeland

the Baltic Sea, the main areas of military activities at sea since 1939, until the war at sea went global in 1942.

Rodewald – Severe Winters

Rodewald⁹, expressed his surprise at the arrival of three cold winters, in particular, that they came so suddenly, and contrary to the principle of conversion of the circulation and temperature deviation. Rodewald¹⁰ points to the air pressure aspects in the Atlantic during the months preceding the winters (1939-42) as follows:

- From October to November a huge area of low depression covers most of Europe. The centre with –11mb (from mean value) is stationed between Norway and Shetland (entrance to the North Sea), which is usually south of Iceland.

Comment: The movement of the centre to the east has most likely been caused by the military activities in Europe's northern seas; whereby increased evaporation would be reflected in lower air pressure.

- December shows an inverse picture. Europe is dominated by a pressure increase of +12mb (from mean value) with the centre west of the Hebrides.

Comment: During the three Decembers (1939-42) the seas in Northern Europe were no longer able to sustain (the usual) maritime conditions. Due to a 'stir and mix' effect, they were too cold and therefore would soon be subjected to continental (high air pressure) influence. According to Rodewald the positive anomaly in December would, by rushing to Northwest Europe in January, actually generate strong Mid European winters. He included in his investigation two other cold winters during the first half of the 20th century, viz. the winters of 1928/29 and 1946/47 (A). An interesting question as to why those winters remained solitary while the winters of 1939-42 came in succession, will be answered only with regard to the latter. As the war at sea during these winters was particularly a war in the North Sea and Baltic Sea, it can be regarded as an evidential indication of a link between the war and the war winters of 1939-42.

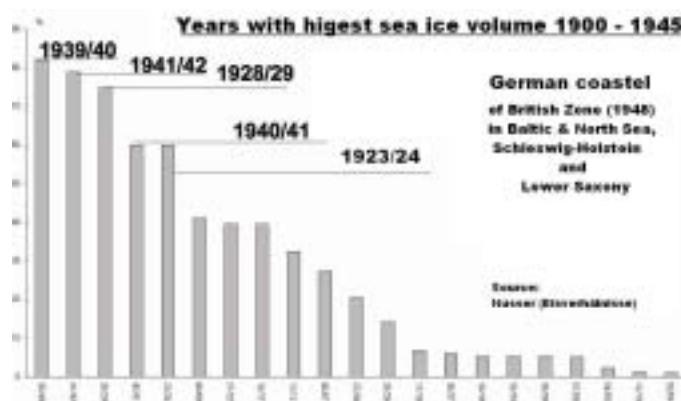
Further details: (A) Winter 1946/47 & 1928/29. (4_21).

Three ice winters in the Baltic Sea

⁹ Rodewald, Winter I

¹⁰ Rodewald, Winter II

A brilliant indicator of the severity of a winter in the Baltic Sea and its bordering countries is the annual feature of icing. With the extent and severity



of ice during the three war winters of 1939-42 it should be possible to provide ample proof that this extraordinary situation could only have been generated by intensive military use of these waters over the time period in question. Main aspects are summarised as follows:

- First and foremost there is the suddenness and severity of each of these ice winters for which no other cause could be attributed than the war at sea.
- It is possible to establish a direct link between the extent of activities in the Baltic Sea and the degree of icing and arctic winter conditions:
 - o 1939/40 intensive military activities, Gdansk, mining western Baltic and Gulf of Finland, Finnish-Russian war at sea, resulted in very heavy ice.
 - o 1940/41 there were only general naval activities and as such icing was less serious compared to the previous year, but nevertheless it was a severe ice winter.
 - o 1941/42 The Germans invaded Russia and had been fighting with the Russian Baltic Fleet for five months during June-December 1941 in the Central and the Northern Baltic Sea, resulting in the most extended and heavy icing ever observed.

Another proof of great importance is the fact that there has never before been such a severe icing. It should be noted that over the observation period the general mean temperatures in Sweden and in the Northern Hemisphere rose roughly one degree, while the winter temperatures in Stockholm had risen about 2°C since 1761¹¹. This comparison of extreme winter situations from the late 18th, or early 19th century to similar events in mid 20th century, will make the latter appear even more severe and extraordinary.

¹¹ Liljequist, Stockholm

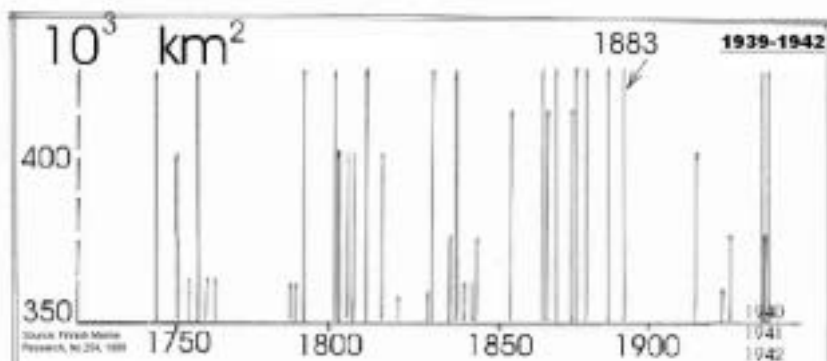
¹² Liljequist, Is 1941/42

As already indicated above, Liljequist¹² observed: Three ice winters in succession are very rare. During almost 200 years of weather observations at Stockholm, there are only two periods that came close to the most recent one in 1939-42. But none of the previous ‘three-winter-periods’ had been as cold as the latter, which was 0.6°C colder than the next group:

Mean value December -March

1783-86; means: -5.6°C	1802-05; means: - 5.7°C	1939-42; means: -6.3°C
---------------------------	----------------------------	---------------------------

A further piece of hard evidence that nothing but the war at sea had turned the Baltic Sea into an ice age like status is the extent of the ice cover during the three years in question. According to a graph by the Finnish Institute¹³, showing the ice cover in the Baltic Sea north of latitude 57° North, there has not been one group of three successive years with so much ice cover since 1720, as during the three war years 1939-1942.



As the graph provided by the Finnish Institute actually shows figures only since 1720, the ice cover during the winters of 1939-42 could have been the most extensive in many hundred years. From the whole period of more than 200 years, only 15 winters reached the highest possible ice volume, including those of 1939/40 and 1941/42. One of the reasons for this rarity of successive high ice coverage is presumably the fact that, from the moment the Baltic Sea reaches a high ice cover, the water body no longer transfers heat to the atmosphere; the deeper waters retaining more heat for the following winter season. But due to the intensive ‘stirring and mixing’ of the sea by military activities, a record ice coverage in the Baltic Sea during the three war years 1939-42 had been achieved, which actually was inevitable. There is virtually no other explanation available.

¹³ Finnish Institute

Europe, the unique receiver of three arctic winters

Europe - the sole generator of arctic winters

It is worth noting that only Europe experienced the three arctic winters during 1939-42. North America and Asia did not go through the same experience. The unique situation concerning the cold January 1940 all over the Northern Hemisphere has been addressed in the chapters, Rain-making (page 107), USA dried out 1939 (page 117), and War in China (page 123). From this follows that the principal source for generating and supporting the arctic winters in Europe, must have originated in Europe. External forces can be excluded with certainty. There is hardly any imaginable influence, which would have been able to introduce three 'Little Ice Age winters' only to North Europe while sparing other regions on the Northern Hemisphere.



British Isles 'three years winter package' 1915-1918

The close similarity between the three war winters of 1939-42 and 1915-18 is the best evidence on the relevance of climatic changes by the war at sea. As already mentioned¹⁴, both periods saw excessive snow during three war years. In the chapter: Europe weather WWI (page 251) it is argued that the winter months of 1915-18 were almost as cold as during the period of 1939-42. The war at sea all around Britain (A) leaves no option but to accept this as evidence of anthropogenic climatic changes.

Further details: (A) War at sea WWI, 5_13; Sea mines WWI, 5_14.

¹⁴ Drummond

Extract from „Climate Change & Naval War – A Scientific Assessment 2005
Trafford on demand publishing, Canada/UK © Arnd Bernaerts

Summary



Quite a number of indications provide sufficient evidence that a succession of three arctic winters, like those of 1939-42, have their origin in the impact of the war machinery on the natural environment. Without even going into too much technical explanation on the 'stirring and mixing' of the seas and resulting consequences, the sheer fact of the sudden occurrence of three arctic winters 'from nowhere', shows sufficient proof that mere 'natural variation' can be definitely excluded as a cause of the extraordinary weather conditions during the winters of 1939-42. The three extreme winters 1939 –1942 in succession are an impeccable example of anthropogenic climatic change.

There was nothing in orbit, in the skies or on earth that could have triggered extraordinarily cold winters for Northern Europe alone. There was nothing but the war at sea.

D. Global sea war and climate changes

Oceans in times of war: 1942 to 1945 (4_11)

Merging together what does not belong?

This section is about global climatic changes. Points in focus are the halt of a warming trend and a slight cooling from 1940 to the mid-1970s. Usually one regards a climate change as something that happens in the atmosphere. Indeed it happens in the atmosphere, as humans feel and see it that way. But this paper does not attempt to follow this approach. It seeks to find explanations for the four-decade cooling process from 1940 to about 1980 in the depth of the seas, contrary to global warming debate.

This section is to deal with global naval warfare during World War Two (WWII). In a brief but convincing form it shall try to draw a picture of the destructive forces of the naval warfare unleashed on the sea body in the areas stretching from the Aleutian, Hawaii and Indonesia to Singapore in the Pacific and from Murmansk, Iceland and Florida to Gibraltar in the Atlantic.



Trying to link changes in the atmosphere to the fighting of battles in the seas seems odd in the first place. It is not so with a 'facilitator' in between.

Main facilitators in this case are the oceans. This investigation is based on the assumption that the ocean is the dominating force on climatic conditions. Climate should be defined as 'the continuation of the oceans by other means', or, as 'the blueprint of the oceans and seas'¹ & ². Water

is of 95% importance in all weather related 'atmospheric components'. Other means refer to water vapour, respectively humidity. Any ocean water released to the air as vapour comes down as rain after 2 to 3 weeks. The weather and climate would not exist without water, and the interconnection of ocean water and humidity is so manifold, strong and interdependent, that the definitions have their own merits.



¹ Bernaerts, Nature

² Bernaerts, Climate 1992, p.23f

Although the picture on the role of the ocean as ‘communicator’ illustrates the situation perfectly, it tells only half the story. Actually, the oceans act according to their ‘own rules’. They are not messengers; they are the rulers of climate. The war at sea may have, ‘by force’, imposed many changes to the ocean waters. Thereupon the oceans will generate a ‘blueprint’ for the atmosphere. The atmosphere will fall in line within a short period of time. Subsequent ‘oceanic conditions’ are the decisive factor of climate.

Quite different from the interaction between ocean and atmosphere is presumably the reaction time between the in-put and out-put a war at sea has on ocean composition and property. Every sea water change inevitable will influence the status of the atmosphere. It might happen within a couple of hours, within a few months, years, or generations. This paper primarily focuses on the latter time periods in support of its theses:

- The old period from about 1940 to 1980 was due to the cooling of mid-latitude ocean areas in the Northern Hemisphere.
- Warm seawater, which the war at sea forced to lower depth levels from 1939-1945, will – one day - contribute to warming the atmosphere.
- The accelerated global warming since the 1980s may partly be traced back to naval activities during war years 1942 –1945.

However, this paper will primarily attempt to present a plausible picture of the war activities at seas during WWII, mainly after Japan’s attack on Pearl Harbour, on December 7th, 1941. The period before this will be dealt with briefly in the next paragraph.

War at sea in the Atlantic, 1939-41

Time period and sea area

The issue of climatic change during WWII has two distinct periods, viz. the period before Pearl Harbour and the one thereafter. From September 1939 until early 1942 naval warfare was largely confined to European waters. The great climatic relevance of the war at sea in the North European waters prior to the winters of 1939/40, 1940/41, and 1941/42 has been extensively discussed in a number of previous chapters, e.g. Winter 1939/40, North Sea cooling. (A)



From a naval point of view also the war at sea in the Mediterranean had been massive and very destructive from 1940 onwards. While it would not be difficult to agree on this point, there is little this investigation could contribute to link this sea area to the climate change issue. Abundant

availability of sunrays, the structure of the water body and the remote interconnection with the Atlantic water system, make the Mediterranean Sea less interesting for this research.

Further details: (A) Winter 1939/49, 2_11; North Sea cooling, 2_16.

Outside Europe's waters naval activities during 1940 and 1941 were largely confined to the North Atlantic. Most affected areas were the transportation routes from Britain to North America, and the routes from Britain to Gibraltar and Dakar. Naval war operations mainly concentrated on the deployment of U-boats by Germans and Italians and hunting and destroying them by the Allies.

U-boats in the Atlantic

A number of German U-boats were already in the Atlantic when the war started in September 1939. Britain introduced the convoy system rapidly. A convoy consisted of up to sixty, either slow or fast vessels, accompanied by up to ten naval escort ships. The first convoy sailed in September 1939. Also in September 1939, groups of three to five naval vessels were formed to control large areas in the North Atlantic. These groups criss-crossed the seas day and night searching for U-boats and dropped depth charges when a U-boat was detected, or assumed to be around.



On September 14th three destroyers hunted U39 and sunk her. Two days later U29 torpedoed the fleet carrier *Courageous* southwest of Ireland. The ship was lost. Until the end of December 1939 the Allies and Neutrals lost 55 vessels with a total tonnage of 300,000 in the Atlantic. Five U-boats were also sunk. The Allies' patrol vessels stopped hundreds of ships, and confiscated goods from

vessels if the crew had not scuttled it. Also surface naval vessels, such as the battleships *Deutschland*, *Scharnhorst* and *Gneisenau* sailed in the Atlantic with a number of escort vessels.

Fighting in the North Atlantic increased during the war years 1940 and 1941. In August 1940 the Germans lifted all restrictions on U-boat targets. The number of available U-boats was 50 (January 1940) and 230 (December 1941) of which about 8 were on permanent mission in the Atlantic during 1940, and 15 during 1941. The total loss inflicted on British, Allied and Neutral shipping in the Atlantic by the Axis powers (U-boats, air force, mine, and surface naval vessels) was 3 million tons in 1940 and 4 million tons in

constituting the main method of attacking U-boats. The charges could be thrown in patterns of up to ten at a time⁴. Later on depth charges, which could explode at a depth of 500 feet, were used. There was also the 'Hedgehog-bomb', fired by a multi-barrelled mortar and filled with Torpex, a much higher-powered explosive. Its range was 250 yards ahead of the escort vessel⁵.

A special chapter deals with the loss of tankers from 1939 to 1941. The British fleet lost 1,469 tank-ships and the Norwegians 430⁶ in just 28 months. If one assumes that the average loading capacity of each ship was 2,000 cargo tons and half of the sunken vessels were laden, the total oil spill could sum up to two million tons in 2 years, an amount corresponding with the total of all major tank ship oils spills between 1967 and 2002.

However, U-boats were not acting alone in the North Atlantic. Since the Luftwaffe could operate out of France since summer 1940, long-range aircraft were sent out into the Atlantic to attack supply routes. The total shipping tonnage sunk by Axis airplanes in all sea areas during the first two war years is claimed to be 1.5 million tons.



War at sea in the Pacific

On December 8th, 1941 The New York Times reported: Yesterday morning Japan attacked the United States at several points in the Pacific, with a major attack on Pearl Harbour. President Roosevelt ordered United States forces into action and a declaration of war was expected soon. Seven hostile actions from a naval ship off the coasts of San Francisco to Malaysia were reported (NYT, 08 December 1941). This was to continue for four years. Allied



forces, viz. USA, Britain and Holland had a total strength of about 220 big naval vessels including 70 submarines; Japanese had 230 naval vessels and 64 submarines in December 1941. Several aircraft carriers were available on both sides, and many thousand airplanes. Recording four years of naval warfare in context with ocean water modification in the upper

⁶ Slader, p.316

level of e.g. 1,000 metres depth is not achievable by a small study. It could only attempt to kindle the readers' imagination as to what the war could have done to the ocean temperature and salinity structure. Oceanic matters have been discussed in the corresponding paper: 'Ocean system affected' (page 225), mentioning that the sea surface temperatures were low from 1945 to 1977 (Source: www.pmel.noaa.gov/).

The clash of the naval forces in the Pacific had no precedence. The fighting included every means and military options. Heavy battles were fought.



Already in May 1942 the combatants met in the Coral Sea each with three dozen ships and several hundred airplanes. In a first attack on May 05th the US Navy destroyed one Japanese destroyer, three minesweepers, and 4 smaller vessels with 22 torpedoes and 76 bombs (each weighing 450 kg). Further attacks followed during next days. On the 8th each side lost about 35 aircraft. The aircraft carrier *Lexington* was sunk by a mighty explosion⁷. The Battle of Midway saw even more naval vessels, more airplanes, and more destruction and losses in June 1942. The Japanese alone deployed more than 200 big naval vessels under five separate commands. The USA and Japan lost a number of naval vessels (more than 120,000 tons), and 400 airplanes (ditto).

Aircraft played a significant role in the Pacific war. Japan's front line strength was its air power consisting of about 4,000 planes; the USA had 4,000 in January 1941, and 22,000 in July 1945. After taking over Okinawa, the US Third fleet had deployed some 26 aircraft carriers, 64 escort carriers and 14,000 combat aircraft for a final attack on Japan⁸. The Japanese loss of combat aircraft was 37,000 (army and navy); the USA lost 8,700 in the battle.

The material loss in the battle was gigantic. Japan lost more than 500 warships (including 150 submarines) with a total tonnage of about 2,000,000, the figure in merchant tonnage was about 8,000,000 of which 5 Mio (1,150 ships) were sunk by US-submarines and 1.5 Mio by airplanes⁹. A special chapter could possibly be written on the sinking of tanker tonnage resulting in oil spills. During the war



⁷ Ruge, p. 64-71

⁸ Overy, p.96

⁹ Overy, p.96

¹⁰ Kemp, Convoy protection, p. 85

years Japan had some 700,000 tonnage permanently afloat and lost 1,500,000-tanker tonnage over the war period. The US lost 52 submarines. Many of them fell pray to depth charges. Kemp¹⁰ explains: The standard Japanese depth charge contained about 230lb of explosives. Anti-submarine bombs carried by aircraft were 131lb and 550lb each, the latter being preferred when available. The Japanese had no means of determining the depth of a submarine to be targeted and so the pattern of attack usually was the dropping of depth charges with a variety of settings on the time fuse. The Japanese lost 150 submarines, many of them to depth charges. It is necessary to consult special literature available in great number and detail even to imagine what happened in the Pacific war theatre. One cannot help getting the impression that WWII left its imprint on the Pacific.

War in the Atlantic, 1942 –1945

Presentation of the theme

As in the previous section, this paper does not intend to give a historical and detailed picture of naval warfare in the Atlantic. This presentation is intended to create simple awareness that war in the oceans can not be ignored with regard to four decades of declining temperatures in the Northern Hemisphere. The mention of heavy ‘turning the sea about’ shall also indicate the serious possibility, that the warm water that had been forced into greater water depths, will eventually ‘resurface’ after years or generations, viz. since about 1980.

The so-called Battle of the Atlantic was actually a fight by German U-boats against Britain’s supply lines through the seas. The merchantmen sailed in convoys. These convoys were escorted by a number of specialised naval vessels, or received air cover.

This presentation will raise a number of relevant issues but without maintaining chronological order or observing military and historical relevance. All dates and figures are only rough estimations.

Aerial warfare over the Atlantic

The use of the planes in war in the Atlantic made tremendous headway since the USA had entered the war after the Pearl Harbor attack in December 1941. The US production was estimated at 127,000 planes in 1942, exceeding the total number of German aircraft production during the whole war period¹¹. It meant that more aircraft with much better quality and capability were available for surveillance, bombing and combat missions in the Atlantic. Even in August 1942 only eighteen American B-24 aircraft, called ‘Liberator’ were available to service Atlantic convoys. These planes had a

¹¹ Overy, p.62

¹² Slader, p.148

¹³ Overy, p.71

range of 2,400 miles, had fuel tanks of 2,500 gallons and reached heights of 30,000 feet¹². From the winter 1942/43 onwards long-range aircraft were assigned for anti-submarine warfare in the Atlantic, which sunk 33 submarines between April 1943 and September 1944¹³. 209 long-range bomber aircraft were available to the US navy in July 1942. The number increased progressively to 2,200 searching and chasing U-boats between June 1943 and May 1944¹⁴.

U-boats, vice-versa, got very little support from the Luftwaffe in 1942 and 1943 but even that little became less and diminished after D-Day (1944), while the Allies' air force presence in the Atlantic improved impressively. The British Coastal Command flew approximately 238,000 sorties, totalling 1,300,000 flying hours¹⁵. Fourteen U-boats were confirmed destroyed with another twelve damaged.

The German Luftwaffe had not been well equipped to put up a significant performance in the North Atlantic battle. However, they had a few hundred long-range four engine planes in service, which flew from bases in France in 1941. During the month of August 1941, they succeeded in sinking more than 300.000 tons of shipping, i.e. almost one-third more than the U-boats sank in the same month. Axis airplanes shall have sunk a total of about 800 merchant ships in all war theatres. Even if less than half of that number has been sunk in the sensitive waters of the Northern Atlantic and Northern Pacific, it actually meant the use of many ten-thousands of bombs and the fall of many thousands of planes into the oceans as well.

U-boats off Florida and Cape Hatteras - 1942



There was a short period from January to about June 1942 when U-boats operated extremely successfully along America's East coast. Within half a year they had sunk about 400 vessels. In two weeks a handful U-boats could sink 25 ships with a total tonnage of 200,000, of which 70% were tankers. In summer 1942 the U-boat operation 'Paukensschlag' (Drumbeat) ended. The US Navy had become effective.

¹⁴ Bernaerts, Atlantic

¹⁵ Thomas, p.249

The Gulf Current flows from Florida to Cape Hatteras, before turning at Cape Hatteras into the Atlantic to go eastwards to Europe. The warm current on the one hand and the colder Atlantic water off Cape Hatteras on the other, built a highly sensitive water body having a significant impact on daily weather, the seasons and climatic conditions in the Northern Hemisphere. Waging a war at sea in these waters is presumably effective in introducing changes to the sea water sphere.

U-boats

In August 1942 the German U-boat fleet had reached the number of 340, which was almost 300 boats more than three years earlier. During the whole war period, the U-boat force had comprised about 1,100 boats, of which 850 participated in at least one combat mission, 630 were destroyed in enemy attacks.

- Loss incurred by German U-boat attacks (all told) is 2,822 vessels (14,220,000 tons).
- The Italians 152 boats sank 132 vessels (700,000 tons).
- The Axis U-boat fleet (German, Italian, Japanese) is credited with the sinking of 25 big naval vessels, 41 destroyers and about 150 other naval vessels¹⁶.

Main field of operation of the U-boats was the Atlantic. They were quite successful only in 1942 until March 1943.

Atlantic Convoys

A convoy was a group of 30 to 70 ships organised to travel in a fixed formation and in a given direction (zigzagging) in order to minimise the threat from torpedoes¹⁷. A naval escort protected the convoy. These escort vessels were able to hunt and depth charge U-boats. During the early times of the war, the escort was small in number and was usually not staying with the group for the full travel distance. By 1941 the average size of a convoy was about forty ships with six naval vessels as escort. Later some escorts became quite massive. For example, in 1942, Convoy ON202 with 38 merchant ships had an escort of 3 destroyers and 3 corvettes; while the escort for Convoy ONS18 comprised 6 destroyers, 8 corvettes, and one trawler.



¹⁶ Potter, p.550

¹⁷ Bernaerts, Atlantic¹

¹⁸ Slader, p.152

In March 1943 two convoys, viz. SC122 and HX229 encountered forty-four U-boat attacks on their route. During the three-day battle that ensued, twenty-three merchantmen were sunk from the two convoys¹⁸. At the same time, convoy HX229A, which included thirteen tankers, eight refrigerator and four cargo liners (39 ships), was routed northeast towards Greenland. There they came upon Arctic conditions (ditto). Three convoys with a total of 131 ships carried about 1,000,000 tons of cargo – petroleum fuel, frozen meat, food, tobacco, grain, timber, minerals, steel, gunpowder, detonators, bombs, shells, lorries, locomotives, invasion barges, aircraft and tanks (ditto).

The Allies completed over 300,000 Atlantic voyages during the period of the war¹⁹.

Tankers

The destiny of many tankers proved extremely disastrous for their crew and presumably the ocean area also. The Allied and Neutral countries had about 1,000 tankers in service since 1942. The loss of tankers with a size over 1,600 tons between December 1941 and May 1944 was 4,221 ships²⁰.



Report 1, October 1941, (extract):
“Attacking from inside the convoy between the seventh and eighth column, U-432 torpedoed the Norwegian tanker *Barfonn*. U-558 destroyed British *W.C.Teagle* and Norwegian *Erviken*, both laden with aviation spirit. Tankers could merit the description of a ‘floating volcanos’²¹.

Report 2, November 15, 1942 (extract):

“Shortly after 3.00 a.m. all hell was let loose. The *Avenger* was hit by two torpedoes and being little more than a large floating petrol can, she blew up instantly in a sheet of flame.....an enormous bright red glow on the near horizon where *Avenger* blew up”²².

Ammunition ships

Report 3, 1942, (extract):

To the southwest of Ireland convoy SC107 lost fifteen merchantmen from its forty-two vessels during the last week of November. The attack came from a pack of sixteen U-boats. After sinking two vessels and the *Empire Linx*, U-132 was on target for being bombed by a Liberator of 120 Squadron. Then

¹⁹ Winton, p.320

²² Thomas, p.178

²⁰ Slader, p.317

²³ Slader, p.147

²¹ Slader, p.144

from beneath the water came a tremendous explosion as *Empire Linx*, an ammunition ship blew up. It is assumed that U-132 was within lethal range and thus became a victim of her own victory²³.

Report 4, 1941, (extract):

Sugar carrier *Silvercedar* had been loaded in New York with high explosives in the holds and bombers on deck. Amidst the wind gale of 8-9 Beaufort a torpedo struck her in hold No.3 which was loaded with condensed milk. *Silvercedar* blew up with a mighty explosion and sunk in less than two minutes²⁴.

Depth Charges

Report 5, 1941, (extract):

U-94 came upon the convoy and sank two ships, then suffered damage a from depth charge counterattack by *Amazon*, *Bulldog* and *Rochester*. The battle lasted four hours. The attacker account said eighty-one depth charges were used, the U-boat commander acknowledged only sixty-seven.



Report 6, March 1944 (extract):

On 29 February, frigates *Gore*, *Garlies*, *Affleck* and *Gould* attacked U-358 with depth charges and Hedgehogs. They held contact virtually continuously until next day, 1st March, but although they made one 'creeping attack' of 104 depth charges, which detonated like 'a marine convulsion', their enemy lay very deep, and very low, and very stubborn. The hunt was

carried on for thirty-eight hours²⁵. How many depth charges the three frigates eventually dropped in total is not mentioned. It seems it could go into many hundreds.

As already mentioned earlier: One of the most effective means of penetrating deep below the sea surface is the depth charge. Depth charges, which could explode at a depth of 500 feet, were in use since 1942. The 'Hedgehog bomb', fired by a multi-barrelled mortar and filled with Torpex, a highly-powered explosive, was also in use. Its range was 250 yards ahead of the escort vessel²⁶. Attacking ships could fire twenty-six depth charges in pairs,

²⁴ Slader, p.147, p. 316

²⁵ Winton, p.306

²⁶ Winton, p.306

set to explode at 500 feet and 740 feet alternately, at ten-second intervals, whilst continuing to steam ahead of the U-boat²⁶.

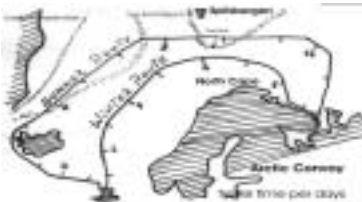
It seems difficult to obtain reliable figures with regard to the number of the depth charges dropped in the Atlantic or Pacific. The total figure could be as high as 500,000 or even more.

The Gunner

Due to experience in WWI transport ships were equipped with guns to defend themselves against U-boats and surface raiders. Within 12 months some 3,000 vessels were armed with a 4.7-inch gun manned by trained gunners, usually six.

Report 7 (extract): *Orient City* was attacked in a convoy at night by a Focke-Wulf bomber. The gunner trained his gun as the aeroplane approached which flew straight into the shell-burst. The aircraft's engine stopped as if switched off suddenly. It fell into the sea like a giant leaf. As it crashed, its bomb-load, intended for the *Orient City*, exploded²⁷.

Arctic Convoy



Russians received about 4,000,000 tons of cargo, including 7,000 aircraft and 5,000 tanks via the most difficult and dangerous route from Britain to Murmansk. It was climatically the most sensitive sea route; presumably manifold more effective to climate changes than

naval activities one thousand miles further south. Out of the total cargo shipped, 7% was lost at sea. Danger came not only from the arctic climate during most of the year, but from attacks by the German Navy and Luftwaffe from their bases in North Norway. At peak time the Luftwaffe had 264 aircraft in the area²⁸, while the British Fleet Air Arm and the Royal Air Force flew 17 combat missions to North Norway from January 1942 to November 1944, involving a total of 600 airplanes²⁹.



²⁷ Slader, p.54
Convoy

²⁸ Schofield, p.182

²⁹ Kemp, Arctic

Convoys started to sail in August 1941; the 35th convoy sailed in May 1945; convoys guarded a total of 715 ships. The loss of merchant ships was 100 with 600,000 tons. The German side lost five surface naval ships including a battle ship and a battle cruiser and 32 submarines. The British Navy lost 20 surface vessels and one submarine.

To avoid the confrontation with German forces the convoys sometimes travelled far to the North. For example: Ships of convoy PC17 navigated in July 1942 close to Edge Island (Spitsbergen) 77°N, and at the edge of the ice border, but were still attacked by aircraft of the Luftwaffe and U-boats.

Report 8 (extract):

An anti-aircraft gunner who was on service on the high-octane tanker the steamer *Bolton Castle* which was



Arctic Convoy bombed

sunk from the ill-fated Arctic Convoy PQ17 reported: “We were sunk in the ice fields and the ship sank in thirteen minutes³⁰. Sunk by three bombs of a Junker 88, the *Bolton Castle*, which had hundreds of tons of cordite in cargo hold 2, looked ‘like a giant Roman candle’³¹.



Of the 35 cargo ships and three rescue vessels convoy PQ17 consisted of, only 11 vessels and two rescue ships survived³².

By and large the convoys were escorted by a considerable number of naval ships. Fighting East and West from the North Cape produced some of the hardest fought battles of WWII³³. For the Norwegian and Barents Sea the military presence will not have passed by without any impact on the sea. Unfortunately, one does not know any details. Although the following information has also been given somewhere else, it seems reasonable to repeat it here:

Barents Sea: Lamb³⁴ reproduces data from

³⁰ Slader, p.54

³³ Schofield, p.1

³¹ Slader, p.101

³⁴ Lamb, p.532

³² Slader, p.100

³⁵ Hartmann, p.241

Rodewald (1972) showing that at Franz Josephs Land (80°N, 53°E) a deep fall in temperatures occurred in 1950 by over 5°C in one decade after the mean temperatures had varied between -10°C and -11°C between 1936 – 1950.

A connection between WWII activities in North and the drop in temperature cannot be excluded.

Atlantic Sea Mines

A 110,000 mines strong barrage laid by Britain between 1940 and 1943 between Orkney and Iceland, received little notice. The mines 'Mk XX' were supposed to prevent U-boats from reaching shipping routes in the Atlantic³⁵. Whether the barrage was a serious threat to U-boats is not known, but it seems not. It would have been a tremendous threat to the sea if the mines had tended to explode prematurely.



It is not clear as to what happened to the mine barrage after the war ended. Were the mines 'gone' by 1945? Were remaining mines swept after 1945? The British deployed 300 minesweepers on the assumption that it would take 549 days to clear moored mines and 676 days for ground mines around its coast³⁶. The Germans also were made to address the issue with the deployment of about 400 minesweepers.

Summary

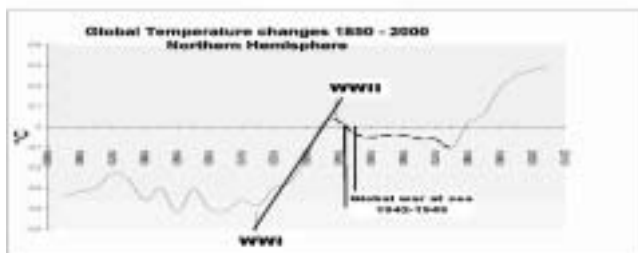
Even though only very little information could be conveyed in a brief paper about the naval warfare from 1942 to 1945, it is hoped to be educative enough to raise the awareness that oceans had been 'stirred and shaken' in a way that could have caused their extra normal cooling for four decades.



³⁶ Elliot, p.170

Ocean System affected (4_12)

Oceans as a theme



It is true that the North Atlantic has a huge heat storage and a circulation system that sustains human life in the

Northern Hemisphere. It is even truer that this water body is extremely variable and will never repeat itself. But the most reliable fact is that this system will survive, even the next Ice Age.

If an ocean has so much ‘potential’, the question is: Can a war at sea influence the natural course of an ocean structural system? The answer is clear! A war at sea can indeed influence the course by multiple means. Actually, manipulating the ocean system would possibly be one of the easiest and most sufficient ways of changing the course of the climate. This option is fully reflected in the definition this investigation is based on: ‘Climate is the continuation of the ocean by other means’. Once the original (the seas) is changed, the copy (the atmosphere) will reflect those changes^{1&2}. For this reason it seems better to analyse the factors, which would indicate the change of ocean dynamics, viz. means, forces, location, time, and the period of time.

World War One (WWI) and the Northern North Atlantic

Nobody has seriously undertaken to study the subject until now. Unfortunately, during two world wars in the last century, parties to war had unknowingly put the matter to test without any idea that extensive war at sea activities could change the course of climate. With regard to the sudden warming at Spitsbergen in 1918 (A), and subsequently in the North Atlantic rim with staggered time periods in Greenland, Iceland and Europe, it has been proved that there was only the war at sea around Britain to blame immediately before the climatic change occurred in 1918.

This sudden increase in temperature remained stable at a number of locations, and in the whole of Europe for two decades, which is an important point of evidence to support the thesis about the relationship between war at sea activities and the change in climate. Huge warm water masses must have

¹ Bernaerts, Nature

² Bernaerts, Climate 1992, p.23f

reached the Northern Atlantic and remained there, particularly in the depths of the Norwegian and Greenland Sea, by supplying warmer water to Greenland in the early 1920s, resulting in the emergence of the Dust Bowl in 1931, which ensured the warming of Europe until the commencement of WWII. (B)

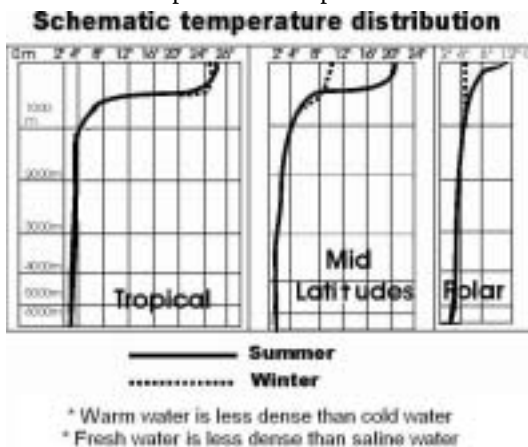
Further details: (A) Spitsbergen warming, 5_12; (B) Greening of Greenland, 5_15.

World War Two (WWII) and the Ocean System in the Northern Hemisphere

Providing a similar chain of circumstantial evidence in respect of WWII is difficult, much more difficult than in respect of WWI. As Kelly et. al.³ observed some time ago (1982): “There is some evidence that the pattern of Arctic cooling that occurred after 1940 was more complex than the warming that affected the whole Arctic during the 1920s and 1930s”.

This ‘higher complexity’ is not due to less intensity in fighting, or that there had been a ‘smaller experiment’ during 1939-1945 than during 1914-1918. But ironically WWII was a much bigger calibre event than WWI. WWII was on a much higher platform with respect to the deployment of ‘destructive forces’. The forces unleashed were more severe than 20 years earlier. During WWII all parts of the North Atlantic and the East Pacific became battlefields. All corners of the seas had seen severe war at sea actions.

The WWII war machinery could directly penetrate lower sea levels never reached before, viz. 200-300 metres deep or still deeper. WWII was also fought in the most climate-sensitive parts of the Northern Oceans, the Aleutian and in the triangle: Greenland, Norwegian and Barents Sea. More than 100,000 sea mines had been moored across the North Atlantic from Faroe Island to Iceland and to Greenland. On the Atlantic convoy routes between 300,000 to 1 million depth charges



³ Kelly

could have been dropped on submarines, and many hundred thousands of bombs, torpedoes, or shells, and ships and air planes sank to the sea bottom.

Two-and-a-half years of war at sea in European waters from 1939 to 1942, were followed by the global war at sea from 1942 to 1945. The Northern Pacific had suffered in the war, but the USA managed to keep the eastern part of the North Pacific (east of Hawaii) 'battle free'. An 'impact report' of the war in the Atlantic and the Pacific is given in the previous chapter: Oceans at war.

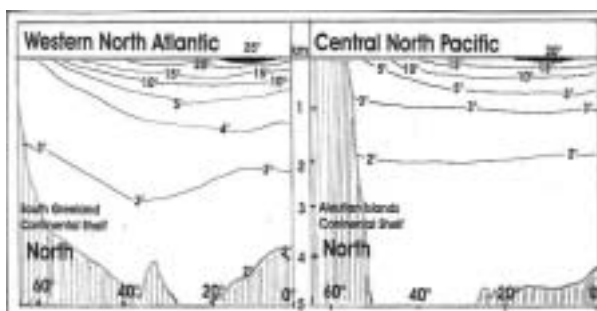
Under these circumstances it would be unpardonable to exclude WWII from being the prime cause for the climate change from winter 1939/40 to the end of WWII and also for the cold period until the late 1970s. As explained elsewhere, the immediate result of WWII covers two phases:

- The time from September 1, 1939 until the third war winter of 1941/42, when the war at sea turned global after the Pearl Harbour attack on December 7, 1941.
- The war period from early 1942 until the armistices with Germany and Japan in 1945.

Although WWII came to an end in 1945, the climate remained cooler than before the war and remained so until the end of the 1970s.

The immediate impact of the war at sea since 1942, when it went global, until 1945 will be discussed in this paper under following sections:

- o Some oceanographic features of the North Atlantic
- o Some oceanographic features of the Northern Pacific
- o Different impacts of WWI and WWII
- o 'Global Warming' or 'Cooling': is this an oceanic question?



In a later chapter (Climatic shifts) the short- and long-term impact of WWII during the three phases, viz. 1939/42, 1942-1945, and particularly 1945-1980, including the

extreme winter in Northern Europe in 1946/47, will be elaborately discussed. But the assessment of the long-term impact of WWII does not stop with the end of the cold period in the 1970s, but raises such questions as: Is it not possible that the impact of the war at sea on the oceans is still reflected in the

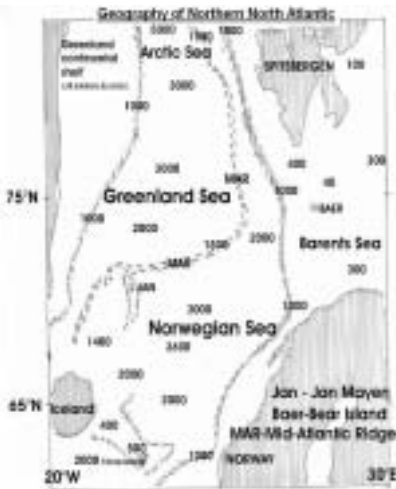
increased warming since the 1980s? Is the world's day-by-day treatment of the seas over the past 150 years not the most relevant source of warming of the global climate? Therefore, the concluding remarks will be made on the warming trend since the middle of the 19th century by discussing which conclusions should be drawn from the two 'shifts' caused by two wars at sea in the 20th century, and what role the oceans played with regard to the warming since the 1980s until today.

Some Features of the North Atlantic

The Atlantic since 1942

Roger Pocklington⁴ summarized the North Atlantic conditions after WWII in 1972 as follows:

"Over the last 2 decades it has become apparent that the worldwide warming of the climate observed since the turn of the century has been reversed, particularly in the North Temperate zone. A steep decline in sea and air temperatures in the Canadian Maritime provinces and New England, a quasi-linear decline in mean winter air temperature from the high Arctic to north Iceland with active ice formation off that coast, a delay in the initiation and development of the spring plankton bloom in the Norwegian Sea, and other changes have been observed. A cooling trend in sea surface temperatures as measured at nine North Atlantic Ocean weather stations has been established."



Kelly⁵ states that the Northern Hemisphere warmed from 1880 to 1940 by 0.7°C and then fell to 0.2°C by the 1960s, whereby the low and middle latitude underwent a cooling during the period 1951-1975, the higher latitude cooled until the mid-1960s after which a slight warming occurred.

"The cooling which began ca. 1940 was delayed in spring and autumn until the mid-1950s, and occurred very abruptly in winters during the mid-1940s."

"The cooling after the 1940s has been more complex (as the 1920s warming) affecting different regions, particularly the western and eastern hemisphere, at different times."

⁴ Pocklington

⁵ Kelly

The authors C.K. Folland et al.⁶ writing in 1992 concerning 'Deep Ocean Heat Storage' provided the following explanation:

"A possible cause of the cooling trend in the Northern Hemisphere between the 1940s and the 1960s relates to a change in the ocean circulation in the North Atlantic which temporarily took more heat from the atmosphere into the deep ocean".

This paper considers a different scenario as the cause. The cooling was related to interior processes within the North Atlantic water bodies sustaining cooler water in the upper levels for a number of years after WWII.

Two water basins and two water bodies

It has been known for a long time that only the northern arm of the Gulf current prevents the Northern Hemisphere from being covered by ice mountains, due to the thermal potential and the current circulation system within the huge water body between Greenland, Iceland, Scotland and Norway, and due to the capacity of the Arctic Basin to 'consume' a permanent inflow of water. Temperature and salinity differences within the sea water body are the principal internal forces setting the system in motion,



while external forces (solar radiation, wind, rain, ice, rivers, etc) may only have an immediate direct effect on the upper sea surface layer. These two factors determine the density of water, e.g. more dense water sinks; thus the water at the bottom is the densest.

What matters in the first place is the thermocline structure. Practically all physical processes occurring in the sea have an effect on thermocline characteristics⁷. The seasonal characteristic is the most pronounced. In the northern North Sea (Aberdeen) the

difference is 6-7°C between summer and winter in the surface layer at 40 metres depth and about half that figure in the North Atlantic. However, below these layers the water is only remotely affected seasonally. For a water column to be stable, its density must increase downwards.

According to its profile, the ocean can be divided into three layers:

- (a) upper, wind-mixed zone;
- (b) thermocline (beginning at 100 metres up to 1000 metres); and

⁶ Folland, Observed, p.165. ⁷ Parker, p.495

- (c) uniformly deep region (lower than about 1,000 metres), with uniform temperatures and salinity.

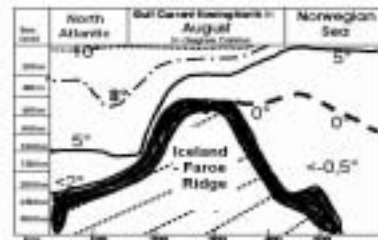


The Norwegian and Greenland Seas are the major source regions of water below the thermocline in the northern hemisphere. Water from these seas sinks and flows southwards, mixing with overlying waters from the North Atlantic Deep water (2°C with a salinity of 34.95 per mille).

Any process influencing the decrease in the salt content of the northern Atlantic surface waters (increased precipitation, decreased evaporation, or ice-sheet, iceberg and sea ice melting) would act to decrease the conveyor-belt circulation system and thus the flow of ocean heat towards the pole⁸.

Middle and Northern North Atlantic

Actually, these parts of the oceans are very different and have separate systems, interconnected by three principal 'gates', one for incoming water, two for outgoing water. The inflow of Atlantic Gulf Current water into the Norwegian Sea takes place mainly through a small channel between Scotland and Faroe Island. The inflow is about 3 million cubic metres per second. As the inflowing water has a high salinity, it is denser and tends to sink the cooler it gets⁹. The Faroe Bank Channel has a minimum sill depth of 800 metres and that is the deepest known passage through the Greenland-Scotland ridge by approximately 200 metres¹⁰.



The main outflow back to the Atlantic is through the Denmark Straits, west of Iceland. The third gate is not actually a gate but more a 'spill over' along the Iceland - Faroe ridge. Very deep cold water from the Norwegian Sea travels southwards, as far as 50° South¹¹.

A very substantial part of the Gulf Current water which has passed Faroe Island, continues as Norwegian Current flowing northwards to the Arctic. A

⁸ Lehman

⁹ Sverdrup, p 174

¹⁰ Crease

¹¹ Kennish, p.102

part of the water continues to flow to the Arctic Sea; a smaller part to the Barents Sea and another part of the water turns west to circle the Greenland Sea.

Here in the northern North Atlantic water can stay in the surface layer or the thermocline (100 – 1000 metres depth) region for many years or decades or go down to the deep basin, forcing, for example, less dense or less colder water to higher levels.



A war at sea can interfere with the above-mentioned 'natural process' innumerable times every day. A sinking ship, a submerged U-boat, an exploding depth charge, etc. can change the temperature and salinity composition

of the water, sometimes only to depths of a few metres, sometimes over 200 metres and sometimes over 2,000 metres. A sunken ship may release thousands of tons of cargo into the sea at depths of 50, 1000 metres or even deeper below sea surface.

But it is not only this 'stirring and mixing' by events mentioned above that may change a certain part of the sea body, but it could initiate a 'turbulent process' that would increase the mixing. It may happen every time when the 'equilibrium' between temperature and salinity is no longer 'tuned'. A new equilibrium must be found. This might occur in rotary motions, just like a tornado (eddies or gyres), that can move water masses further up or further down.

What could a sea body, with regard to temperatures and salinity structures look like after a convoy such as SC 118 consisting of 64 slow vessels had finished its Atlantic crossing? The convoy covering a wide area of over fifty square-miles had a very large fleet of escort vessels after two more US destroyers and a coastguard cutter had joined somewhere south of Greenland in heavy sea on 5 February 1943. From 60 submarines in the area, 16 were sent to form a trap. It became a feast for the hunter but a nightmare for the hunted. Thirteen ships were sunk by torpedoes; followed by three depth-charged submarines¹².

¹² Slader, p 150

Two weeks later, westbound convoy ONS 166 consisted of sixty-three vessels and six escort vessels. Hampered by constant northwest gales, the convoy gained only 4 knots (ca. 8 km/h) over four days, upon which a five days battle commenced which covered over 1,000 miles of ocean. In the course of this battle 14 vessels were sunk. One long distance airplane sank U-623. At that time these airplanes (VLR Liberator) were able to stay in the air for half a day and to search and attack submarines for hours.

With regard to the Norwegian Sea the Arctic convoys between Britain and Murmansk, frequently under attack by the Reichsmarine and Luftwaffe, must have brought considerable disturbance to this sensitive area of the sea. One disastrous event was the destruction of 13 vessels within 24 hours by more than 150 German bomber airplanes and a number of submarines on July 5/6, 1942¹³. An overview of the convoy operations, together with further information concerning the battles unleashed in the seas, has been given in the previous chapter.



While considering this aspect it can hardly go unnoticed, that the oceans from the Arctic Circle down to the equator had never been stirred and turned upside-

down to the same extent as during WWII and particularly since the war at sea went global in December 1941.

Arctic

Some meteorological events in brief:

Arctic According to Lamb¹⁴, the geography of surface temperature changes continued to show the greatest cooling from the 1940 level in the Arctic (Lamb provides a list of the number of warmer and colder months north of 70°N during the 1950s to 1970s in Table 18.8/9).

¹³ Schofield, p.58 ¹⁴ Lamb, p.531 ¹⁵ Jones, Surface

Arctic According to Jones et al¹⁵ the early 1940s were notably cold over the Greenland Sea and northwest Europe in winter although longer term cooling in winter did not affect the Greenland sector until later. 1943, 1944 and 1947 were notably warm years in the Arctic.

Arctic Jones et al¹⁶:

- By the 1960s, the Arctic as a whole had cooled by ca. 0.85°C since the 1930s. The coldness of the 1960s was pronounced in the Kara Sea region.
- In the 1970s the warming began to affect the Arctic during the first half of this decade, particularly in the Barents Sea and Kara Sea region.

Spitsbergen; Hesselberg¹⁷: The mean temperatures recorded at Isfjord from 1912 to around 1955 show that the mean temperature did not ‘jump’ during WWII as it had done twenty years earlier. Actually, after a ‘down time’ during the winter 1939 – 1945, the mean varied on a ‘neutral’ basis.

Barents Sea Lamb¹⁸ reproduces data from Rodewald (1972) showing that at Franz Josephs Land (80°N, 53°E) a deep fall in temperatures occurred in 1950 by over 5°C in one decade after the mean temperatures had varied between -10°C and - 11°C between 1936 and 1950.

Kola peninsula The highest water temperature in the top 200m of the Barents Sea at 70-72°N, 33°E north of the Kola peninsula, appeared to have been reached already in the 1935-39 period and despite a secondary maximum about 1951-55 had fallen by 0.5°C in 1960¹⁹.

Winter icing in the Northern Atlantic 1939-45

The extent of winter icing in the Northern Atlantic may sometimes hold a clue as to what ‘the climate is doing’. With regard to the war period this seems difficult, if not impossible. The long-term situation was summarised by Nusser²⁰, in the 1950s as follows:

“In the 1890s and around the turn of the century Jan Mayen island was surrounded by ice each winter and spring. Now it lies at the extreme edge of the ice, due to the general withdrawal of ice. For instance, in 1930 only in March did the ice come to 20 miles off Jan Mayen. However, ice-free years are succeeded in turn by years rich with ice, as for instance, the year 1942 when the isle was surrounded

¹⁶ Jones, Surface

¹⁷ Hesselberg, p.23, Fig. 2

¹⁸ Lamb, p.532

¹⁹ Lamb, p.528

²⁰ Nusser, Arctic

²¹ Personal Communication

However, it seems remarkable that the annual reach of ice was restrained. This can be regarded as proof that WWII had not reversed the warming trend that had started at Spitsbergen in 1918. It could even mean that, as in 1918, the Norwegian Sea received another push for a 'little warming up' (see next section Rodewald).

A complete picture of the variations in the extent of Arctic sea ice at the end of the winter and summer, during the period from 1901 to 1955, is given by Lamb²⁴.

Sea surface temperature observation – North Atlantic

Sea surface temperatures (SST) on record are a helpful tool in research, but difficult to handle for a number of reasons²⁵. To name only two: (1) the fact that for a long period of time most of the data had been collected by merchant ships during their voyages and (2) available data is extremely limited considering the relationship of the oceans and the climate system. The SST data collected especially during war time must be treated with particular care²⁶. This paper will therefore refer briefly to a few scientific opinions as how to interpret SST data relating to the North Atlantic after WWII. The references are only selective and not necessarily complete.

Goudie²⁷ assessed about 1977: Water temperatures over most of the North Atlantic north of 40° have shown some decline in recent years, with sharp falls up to 2.5°C in the 1950s in the west Atlantic between 40° and 60°N.



Rodewald²⁸;
Information
provided by
Rodewald on those
SST data taken by
ocean weather
stations from 1951
to 1960. They are
possibly the most
reliable data
during that period
of time. The
general trend at
these stations has
been as follows:

²⁵ Bernaerts, Atlantic

²⁶ Bernaerts, Pacific

²⁷ Goudie, p.146

²⁸ Rodewald, Sea-surface

	Sea Area (at station, e.g. M, A)	Major trend 1951-60	10-year means	Average
M	Norwegian Sea	Increase until 1955, total + 0,5°C	8.3°C	7.7°C
A	Iceland/Greenland	Increase since 1955	7.1°C	6.7°C
B	Greenland/Newfoundland	Decrease since 1955	5.2 °C	4.8°C
C	Atlantic West (ca. 52N)	Steady decrease	9.0°C	9.4°C
D	Atlantic West (ca. 45N)	Strong decrease	17.3°C	16.6°
E	Atlantic West (ca. 35N)	Decrease until 1957	21.7°C	21.5°
I	Atlantic East (ca. 60N)	Increase since 1954	10.7°C	9.9°C
J	Atlantic East (ca. 45N)	Increase until 1957	12.5°C	12.1°
K	Atlantic East (ca. 35N)	Nearly steady	15.3°C	14.9°

Comment: It seems particularly worth noting that Station ‘M’ in the Norwegian Sea does not show downward temperatures, thus indicating that the major trend since 1918 was in principle not reversed.

On the other hand, sub polar North Atlantic showed a predominantly negative trend that could be regarded as supporting the ‘war at sea’ thesis. Unfortunately, the first series starts six years after WWII had ended.



Destroyer burning and sinking

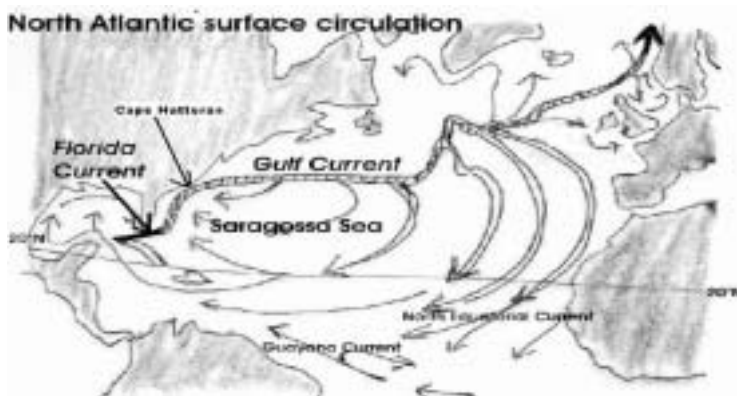
Lamb²⁹: He mentions the sea water data record taken since 1867 at Faeroe Islands stating: “The warmest water was observed between 1940 and 1957, the peak being in 1951 (average 8.9°C)”.

Comment: This can only mean, that the sea south and north of the island was ‘normal’, and obviously disconnected from the continental weather, whereby the high values in the 1940s could be seen as resulting from ‘stir and mix’ processes. The indicated circumstances are a substantial support for the sea war thesis.

²⁹ Lamb, p.508

Lee³⁰: In 1949 south of Bear Island arctic water moved to the south-west over denser Atlantic water, giving rise to an area with marked temperature inversion to the south and west of Bear Island. (Note: The text shall only indicate what is 'happening up there', i.e. how an interaction between Eastern North Atlantic and Barents Sea works).

Folland³¹: On a global basis the warmest decade for marine air temperatures is probably from 1940 to 1949 (anomaly 0.11°C) and the coldest from 1903 to 1912 (anomaly -0.5°C).



Folland³²: "The jump in the level of uncorrected SST anomalies around 1941 and the sudden decrease in the annual cycle of SST in extra tropical regions at the same time provides strong evidence that the chief cause for this was a change in observational practices such as the use of un-insulated buckets to engine intakes that was sudden in many, though not all, parts of the world."

Kushnir³³:

- These new procedures of measuring SST led to an apparent "warming" in measured SST beginning at about 1940.
- The spatial distribution of North Atlantic inter-decadal SST variability also supports the hypothesis that changes in the large-scale oceanic circulation are involved.
- The unique association between the inter-decadal SST pattern and surface meteorological conditions suggests that the atmospheric circulation change may be the response to the change in SST.

³⁰ Lee

³¹ Folland, Worldwide, Figure 4b

³² Folland, Corr. p.330

³³ Kushnir

³⁴ Deser, p.1752

³⁵ Smith

Deser³⁴: It should be noted that the spatial pattern of cooling during the 1950s to 1960s was somewhat different from that of warming during the 1920s and 1930s.

Smith et.al.³⁵: Based on sea-surface anomalies; large, significant cooling in the 40°N to 60°N band occurred at about 1903, 1913, and 1977.

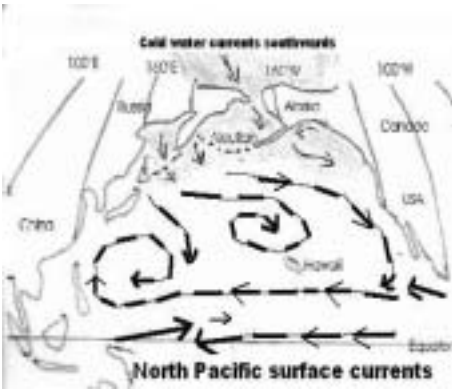
Jones³⁶:

Comparison between coastal land and marine air temperature data: Northern Hemisphere

1861-73	1874-89	1903-41	1942-45	1946-79
-0.35	-0.50	0.23	-0.49	-0.02

Barnett³⁷: All data, however, suggest a multi-year climatic event did occur in the ocean-atmosphere system over much of the globe in the late 1930s till mid 1940s.

Bjerknes³⁸: A ‘time series’, 1850-1960, given for the sea surface temperature south of Iceland indicates a small decrease by 0.5°C from 1945-55.



Hansen³⁹;

- In 1948 the North Atlantic was in a predominantly cold state, with cold anomaly features in both high and low latitudes.
- Maximum subsurface temperature anomalies led those at the surface for as much as 2 years.

Some features of the North Pacific

The Pacific Ocean is by area and volume the greatest and the deepest of all three oceans under study. Although the North Pacific is larger than the North Atlantic, the climatic relevance of the latter for the weather in the Arctic and the upper Northern Hemisphere is several times higher, due to the Atlantic Gulf Current of which a considerable part flows high to the north and into the

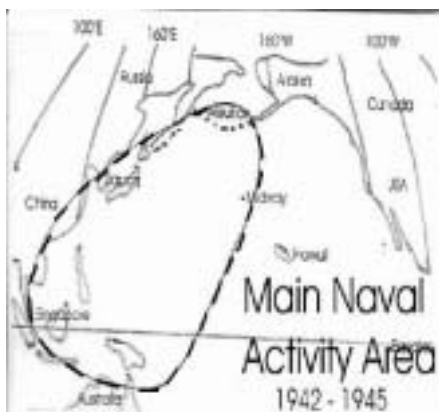
³⁶ Jones, Global ³⁷ Barnett, Surface ³⁸ Bjerknes, Fluctuation, Fig.5
³⁹ Hansen & Bezdek

Arctic Basin. In the Pacific big currents can only go as far north as the Aleutian Islands, that is 50° North, corresponding the latitude of Paris.

A speciality of the North Atlantic (north of the Greenland –Iceland-Scotland ridge) is that cold deep-water masses can form and ‘stay’ in the quasi semi-enclosed seas only in the Norwegian and Greenland Sea. A situation like the sudden warming at Spitsbergen in 1918, and this warming remaining stable for two decades would not be possible in the North Pacific. Here two major sub-polar gyres circle between the Equator and 40° North. The general temperature structure over the ocean depths is similar to the other seas, although the sea surface is cooler.



The impact of a war at sea in the North Pacific is primarily a matter of ‘stirring’. As a short-term effect colder water would replace warmer surface water. Once heat is stored in the sea it can remain there for months, years, or



decades. ‘Energy’ which has been forced into the depths between 1942 and 1945 could ‘resurface’ after 5, 50 or 100 years. While it is easy to force warm surface water into greater depths within a short time period, it will take much more time to get the heat out again of the water. Once warmer water is in 200, 500 or 1,000 metre depths, by sheer forcing or a current system, it may require many years or generations ‘to get out of the store’ again.

What actually happened in the interiors of the Pacific is not known. That the well-documented war at sea in the Pacific did not leave any impact on the temperature and salinity structure at innumerable ‘places’, and at all sea levels, seems to be almost impossible to believe. In so far it is useful to note that the sea surface temperatures were low from 1945 to 1977 (Source: www.pmel.noaa.gov/).

The wartime data are quite high (ditto). While sea surface temperatures had been taken during war time, due consideration should be given to WWII conditions before applying them⁴⁰.

⁴⁰ Bernaerts, Pacific, p.249

This investigation can only attempt to draw attention to events that, in some way, must have had an impact on the temperature and salinity composition of huge sea water areas, from the surface to considerable depths. For the moment one brief example may provide an impression on what could have happened in one corner of the Pacific.

The Pacific's Northern Front – Aleutian Islands

In June 1942 the Japanese invaded the Aleutian Islands Attu (1,900 km west of Alaska) and Kiska (ca. 1,200 km west of Alaska), belonging to a string of approximately 120 volcano islands between the Bering's Sea and the Pacific stretching from Alaska to Siberia. The seas lying immediately north and south of the islands are deeper than 1,000 metres. Warm water currents from the south and cold Siberian air ensure an unpredictable mix of terrible storms, or a permanently cold weather, with damp fog, or snow, or icy rain, with hardly more than 10 to 14 clear days per year.

In this weather sensitive sea area a 3 ½ year battle at sea, on land, and from the air took place. The war theatre in the high North Pacific was only on the side-line of what took place elsewhere in the Pacific. Hutchison⁴¹ lists in his Fact Book about 2,000 events, not necessarily describing all engagements. The example of July 6, when Japan still occupied Kiska, records the following events:

Three heavy cruisers, one light cruiser and four destroyers bombarded Kiska for 22 minutes. Approximately 100 tons of explosives had been fired. The Japanese sent a rescue force comprising two light cruisers, ten destroyers and a tanker (September 7)⁴².

Hutchison (Lit.: p. xvi -ii)⁴³ gives a brief description as follows (Excerpts): "The U.S. Army retook Attu on 30 May 1943 after one of the bloodiest battles of the Pacific war." "The Kiska invasion, August 1943, proved a costly drill." After retaking the islands, the USA could target Japan's bases on the Kurile Islands.

"For the remainder of the war, American aerial and Naval attacks continued ceaselessly except when weather prevented them. The U.S. Navy bombarded Kuriles 12 times, sweeping the seas clear of enemy craft on six occasions. Fleet Air Wing Four bombed Kuriles 113, and the 404th Bombardment Squadron alone flew 699 sorties. By the war's end, American submarines had sunk at least 220,618 tons of shipping, often surfacing and sinking fishing vessels with gunfire. Approximately 745 Americans soldiers of all

⁴¹ Hutchison

⁴⁴ Bernaerts, Pacific

⁴² Hutchison, p.106

⁴³ Hutchison, p.xvi -ii

branches were killed; the greatest numbers lost in this period were crew of U.S. submarines.”

From 1942 to 1945 the USA supplied the Soviet Union with 6.7 million tons of equipment. The material was sent through a number of heavily escorted convoys from Portland/Oregon to Vladivostok. During this operation 25 Russian vessels were torpedoed and sunk⁴⁴.

A brief overview of the main features of the war at sea in the Pacific has been given in the previous chapter.

Observation of Sea surface, 1939 plus - in the Pacific

Wright⁴⁵ provides the monthly sea surface temperature (SST) anomalies from 1930 to 1960 and the annual SST from 1870 to 1969 for three regions of the North Pacific (20N – 50N). Even if the data taken during WWII is dismissed as being not reliable enough⁴⁶, it seems impossible to take any clue from the data series.

Barnett⁴⁷, reported that sea surface temperature anomalies are largely confined to the surface mixed layer in the North Pacific Ocean.

Different impacts of WWI and WWII



WWI and WWII time periods, viz. 1914-18 and 1939-42 seem to have been quite similar. During these periods the war at sea was mainly fought around Britain. 1916 – 1918 almost as many ships were sunk as during the whole WWII, although WWII had from the first day a much more destructive means and the operational area was wider than at any time during WWI. While in WWI sea mines, submarines, depth charges, etc. were deployed in a greater number only after 1916, i.e. two years after the start of the war, possibly up to 50-100,000 sea mines had already been laid by the end of 1939 itself, i.e. within 4 months of the start of WWII. The Baltic Sea saw many military encounters, and in the North Atlantic a number of German surface naval

vessels and submarines were in operation at any time. As the first 2 ½ years of WWII had been a regional war at sea, could one expect the Northern North Atlantic to react as it did at Spitsbergen in 1918? (A). WWII did not stop in

⁴⁵ Wright

⁴⁶ Bernaerts, Pacific

⁴⁷ Barnett, Pacific

the way as WWI had. Actually, the full ferocity of the war at sea did not start until the Pearl Harbour attack in December 1941. As noted above, WWII had not reversed the pre-war warming trend in the Norwegian Sea that had started in 1918. The trend had only been put ‘on hold’ for some time.

Further detail: (A) Spitsbergen heats up, 5_12.

Differences in the treatment of the oceans by WWI and WWII are quite obvious. WWI could only have initiated indirectly, a ‘reorganisation’ of location and flow of water within the water body north of the Hebrides and Orkney Islands. WWI’s military operations had been extremely destructive south of these islands but had never been extended to the sea areas north of the islands or in the Norwegian Sea, although the North Cape area saw considerable naval activities and many dozen ship sinking.

From the first day of WWII the navies also operated north of the Hebrides, from Norway to Greenland. Therefore, the impact of the war on the Norwegian Sea from 1939 - 42 was not necessarily the same as 20 years earlier, and definitely different after 1941. This seems to be reflected in climatic data, as the Northern North Atlantic water body took eventually a course by not sustaining the upward-warming trend of the atmosphere over the next forty years.



While the Arctic and Northern North Atlantic may have a role in the downward trend of the air temperatures over the Northern Hemisphere, the four decades of cooling could substantially have been generated in the huge



water bodies of the sub polar gyres of the North Atlantic and North Pacific. In the North Atlantic different water bodies, e.g. Gulf Current, North Atlantic Drift and North Equatorial Current, circle the area in decades while eddies may exchange waters over considerable depths, or any other ‘rotary motion’ (see above).

‘Warming’ or ‘Cooling’ - is it an oceanic question?

During WWII the cooling of the Northern Hemisphere had started, lasting until the 1970s. How did it happen? In all oceans, and actually in all sea areas where sun radiation is ‘sufficiently’ available, the answer is very simple. In principle, the war at sea will force warm surface water down and colder water to the surface unless specific conditions prevail. The global war at sea from 1942 to 1945 took place primarily in sub polar waters, south of latitude 60° North, with the consequence that a general cooling was the most likely result. This applies in principle also to the North Atlantic south of Newfoundland, Iceland, and Scotland, although with some modifications during the winter months. To warm a cold body of water takes some time. Heat that has been forced to greater depths of the sea might stay there for decades. In so far this could be the only explanation why there was a cooling for four decades. Any heat stored a long time ago could now accelerate the warming observed since 1980.

The same does not necessarily apply to the Northern North Atlantic and the Arctic Sea. The heat conditions and salinity structure these are heavily influenced by a permanent inflow of warm water, transported, circulated, and processed under a cold sky and many sunless winter days. This made possible the sustained warming of Spitsbergen and of the Northern Hemisphere since 1918, with a time-out between 1939-1979.



An assessment by Jones et. al.⁴⁸ may illustrate this; “As regards the Northern Hemisphere, there seems to be little disagreement on the following: the hemisphere warmed between about 1880 and 1940, and cooled after 1940. There is, however, disagreement on other aspects, particularly on whether the post-1940 cooling has ended, and trends since 1965”. As indicated earlier, the post-war

cooling had only been on a ‘time-out’, initiated and sustained by the 1939-45 war at sea.

⁴⁸ Jones, Surface

Two brief Question. Short answers

- Question: Had the war at sea not gone global in 1942, and had continued at the level of 1939-42, would the winters in Northern Europe have been severe again?
 - o Answer: Most likely, yes.
- Question: Had WWII been stopped before Pearl Harbour event in December 1941, would a cooling have occurred for four decades?
 - o Answer: Presumably not.

Summary

With reference to the previous chapter ‘Oceans at war 1942-45’ (4_11), this paper could do little more than try to highlight the ‘sensitivity’ of the oceans, in that every ‘treatment’ causes a change that might form a new status with short- or long- term consequences on the interaction between the sea surface and the atmosphere. This paper further intends to provide some ideas on what may have happened to the seas where naval activities had taken place. For these reason the opinions of a number of scientists who could assess their valuable work on their own knowledge about the WWII climatic conditions have been considered. The war-at-sea thesis is the most convincing explanation for the global cooling since 1939/42. By having established that the three arctic war winters of 1939/42 in Europe had definitely been caused by the war- at sea- activities in the North and Baltic Sea, it can be assumed with a high certainty that the significant warming of the Northern Hemisphere for two decades since 1919 had also been caused by the war at sea during WWI (forthcoming p. 251) and that a dozen times or more severe global war at sea from 1942-1945, will not have left the oceans ‘unchanged’. Once the oceans change, the climate will change. The blueprint follows the master copy. In winter 1939/40 the war at sea stopped the long-term trend for globally rising temperatures for four decades, which was resumed when the oceans ‘recovered’ in the early 1980s from the treatment during WWII.

Extreme winter of 1946/47 in Europe (4_21)

Introduction

The winter of 1946/47 occurred at a time when the war at sea from 1939-1945 had ended. It does not pertain to the general theme of this study, whether naval warfare has caused the two most significant climatic changes in the last century. Actually, the 20th century had in Europe – in addition to the very cold WWI winters, five extreme winters, viz. 1928/29, 1939-1942, and 1946/47. While this investigation has established that Europe's war winters of 1939-42 remain in closest relationship with the war at sea, the question is: where did the other two arctic winters in Northern Europe emanate from? Does the appearance of these 'peace winters' affect the thesis, that the war at sea has generated the arctic war winters of 1939-42 that changed the climate? This section will discuss this matter in brief, but elaborate in particular the following two aspects:

- The 'war winters' and the 'peace winters' were generated under different circumstances and are of different making.
- It cannot be ignored that roots of both peace winters originated in the two World Wars.

In this study more emphasis will be placed on the former point, i.e. on the 'different' theory, without attempting to indulge in an in-depth research.

Before proceeding with the discussion, one interesting observation relating to the winter 1946/47 deserves a mention. People in Northern Europe who were old enough at the time of the three war winters of 1939-42 to remember them, would tell that the winter of 1946/47 was the coldest they had experienced. Actually, they would only mention the latter one, but not even one of the three arctic war winters. Was it the stress of war that the war winters were obliterated from their memory? Depending on the region, at least one of the three war winters was colder than the winter of 1946/47. No doubt, however, that the second winter after the armistice in 1945 was an arctic in North and Central Europe (North Sea countries), and ranks very high in the list of cold winters.

General features of the 'arctic peace winters'

Most relevant aspects seem to be the following:

- They were late-winters; only the February temperatures were extremely low extending the cold spell into March.
- The air pressure over the Baltic massively increased in February (about 20mb).

- The Northern North Atlantic had a lower air pressure, while increased temperatures were observed.
- In Western Europe (Britain) wind came from east-south-east¹.

A ranking of the coldest winters in Berlin during the period from 1814 to 1964 based on the monthly ‘sum of negative daily means’² may give an indication:

Winter	Berlin, °C
1829/30	-791
1939/40	-636
1946/47	-567
1928/29	-503
1941/42	-474
1962/63	-474

It is particularly to note, that the winter 1946/47 was actually a late winter due to an extreme influx of cold air in February. This is well illustrated by the Danish climate conditions. While January 1947 was only 2,6°C lower then normal, the temperatures in February were 7°C lower then the long-term average³.

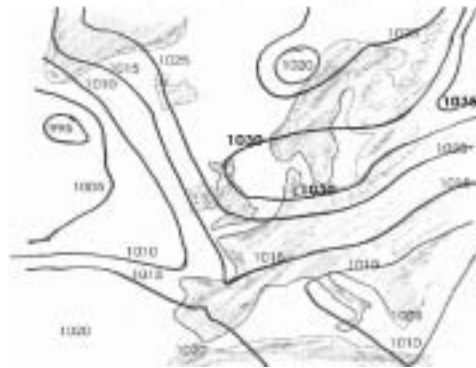
Britain takes record

The winter situation in Britain can be taken as proof that a major cause for extreme weather conditions was the incapability of the seas around the British Isles to prevent the influx of cold continental air due to past and ongoing naval activities, e.g. mine sweeping. The situation is outlined in brief: It was a record cold month

and one of the snowiest since the early 19th century starting in late January only. Temperatures dropped in parts of southern England to –21°C.

February was gloomy, windy and frosty throughout the month. In London the sun was shining less then 70% as usual, indicating that the seas were still acting. From the moment the dull weather disappeared, e.g. after 22nd February some parts of southern England, measured temperatures around –

Weather Map Europe February 16th, 1947



¹ Drummond

² Lenke

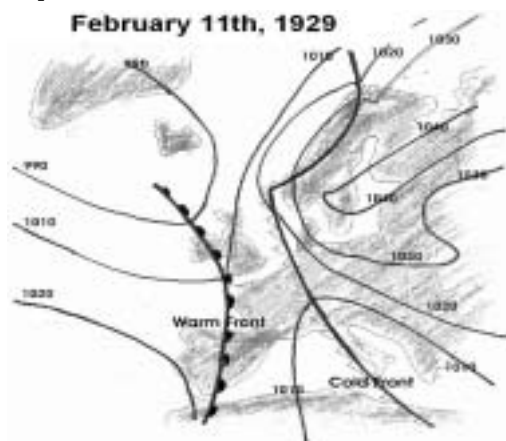
³ Det Danske

20°C. The constantly low temperatures in spite of sky-cover-conditions February 1947 became the coldest February since records began in the 17th century.

The extreme conditions continued in March which was even more out of tune with average then February had been with severe snowstorms in most of England and Wales, ice storm in the South and minus 21°C in the northern part of the Isles. After mid March milder weather caused heavy flooding due to record precipitation three times the average in many parts of Britain. In London it was the third rainiest month since records were taken. Record holder is March 1916 with about 135 hours. By the end of February 1916 the German Kaiserreich announced that armed merchantman would be attacked without warning. In March 1916 German U-boats sank ships with a tonnage of 200.000 tons, or about 4 ships per day.

Winter of 1928/29

February 1929 was at many Middle European stations the coldest ever measured. The deviations were up to minus 8-12°C. In Greenland, however, it was the mildest since observation started⁴. According to Rodewald⁵ the tropical Atlantic was the source of that extreme winter.



Winter of 1946/47

US meteorologist Jerome Namias gives a detailed account in 1947 about the winter of 1946/47⁷. According to his observation, the winter generated a large variation from normal, especially in England, where the climate became continental rather than the normal maritime in winter 1946/47. He establishes, that, in the Northern Hemisphere there remained only two warm areas in February 1947, one in the North Pacific (Alaska), and the other and larger, in the North Atlantic (including the North Pole), while the rest was subject to an extreme arctic cold spell, down to Florida, the Mediterranean, and Japan. Namias attributes the February warmth in Alaska as being associated with the diverted warm maritime Atlantic air. He notes that in the United States extensive mildness prevailed in December and January, giving way to a severe winter cold in February, and describes the features of the January weather chart as follows:

1. The westward intrusion of the Siberian High into Europe (+17mb anomaly over Scandinavia).
2. The absence of the normal low-pressure trough and the storm track from the Icelandic Low north-eastward, and instead, the trough from the intense Icelandic Low through Davis Strait into the Polar Basin.
3. The imprisonment



⁷ Namias

⁸ Lenke

of the North American Polar Continental anticyclone in northwest Canada and the resultant domination of the United States by Pacific air masses and the Great Basin anticyclone.

4. The weakness of the western cell of the Aleutian Low.

Sea ice conditions in the North Sea were more severe than in the Baltic Sea. Icing started early in the south of the Helgoland Bight (December 12th), and at the west coast of Denmark (December 22nd), becoming particularly severe in the eastern North Sea, Skagerrak, and in the Danish Belt passages to the Baltic Sea, being the heaviest icing in the time period 1896-1955.

A detailed assessment of the air pressure situation over the North Atlantic indicates that the seas around Britain had too little heat reserves to prevent cold continental air to reign the air column over the North Sea and English Channel.

Difference between war and peace winters

- War winters were long, lasting from December to March; see for example: Northern Europe plunged into arctic conditions – winter 1939/40 (2_11); the peace winters developed their extreme cold spell not before February⁸.
- Peace winters were rooted in the Northern Atlantic. The war winters of 1939-42 were initiated and sustained in the North and Baltic Sea, as explained in a number of chapters: Sea war events (2_13), North Sea (2_16), Baltic Sea (2_17) and Lost West Drift (2_12).
- During war winters the wind in Britain came from NE-directions; while in the peace winters it came from SE-directions. While the latter situation occurred during several cold winters in England (1904, 1895, 1891, 1879, 1870 and 1845), the NE-directions occurred before 1940, the last time in 1841 and another time in 1814 and in no other year since such observations were recorded since 1788⁹.

Can the winters of 1928/29 and 1946/47 prove something?

With regard to the winter of 1946/47 it seems possible to see a correlation between WWII activities at sea and a temporary shift in the sea water structure of the North Atlantic. The turmoil at sea had not stopped long before the huge amount of ‘stuff’, including bombs, shells and ‘chemicals’, was deposited in the sea, and huge mine sweeping operations continued for some more time after the armistice.

⁹ Drummond

The following record is presumably not a mere coincident. At Greenwich Observatory the temperature was -26.5°C on April 4th 1946 (The Independent, 11th April 1997, p.1). This shows that neither in April 1946, i.e. 10 months after the war had ended, had the Western European seas and ocean areas fully recovered.

The winter of 1928/29 is different as its occurrence took place 10 years after WWI had ended. A link could nevertheless exist via the ‘spread’ of the severe warming during the 1920s.

An interesting aspect remains to be mentioned. Both winters, of 1928/29 and of 1946/47, seem to stand quite ‘solitary’ since the Little Ice Age ceased at about 1880. They may have something to do with a ‘warming variation in the Northern Atlantic’. They had a comparable pattern and severity and their appearance lasted for only one winter. They have left no mark in climate change incidents. In a warming world since 1880, only these two winters were associated with the coldest February temperatures. Over such a long time period they are still very close to the two World Wars.

A very interesting aspect is certainly the El Niño phenomenon that has been reckoned in a previous chapter (West wind lost, 2_12). While 1946/47 is regarded as El Niño period, 1928/29 is listed as an anti-El Niño event (La Niña). Further research would be helpful as it will subsequently support the ‘war at sea’ thesis.

Summary

It could be shown that some sort of anomaly in the North Atlantic made the winters of 1946/47 and 1928/29 abnormally cold. There is no further need to look for clues whether the circumstances of these winters affect the main theses of this investigation. That is not the case.

The result of this elaboration seems nevertheless quite clear. The North Atlantic and the North Pacific generated a situation where polar air masses pushed far to the south.

While the winter of 1928/29 seems at best be distantly connected with the severe warming at Spitsbergen in 1918 without any direct link to WWI ten years earlier, this cannot be said with regard to the late but arctic winter of 1946/47. The latter can be considered a direct consequence of the just ended WWII due to its timing, location and circumstances.

E. Severe Warming 1918

Europe Weather–Influence by WWI (5_11)

Introduction



When the Great War of 1914-1918 commenced, no one had imagined that the war would be so severe and so long. The Kaiser told departing troops: ‘You will be home before the leaves have fallen from the trees’. On August 4, 1914 German troops marched into Belgium. It took four

dramatic years until fighting stopped with the armistice at Versailles.

This study tries to reiterate that the fighting in Central Europe, particularly at sea, had not only modified certain weather patterns, but also influenced climatic changes in European and Northern Atlantic territories. The latter will be dealt with in a different paper. Here the possibilities of weather modifications during WWI are discussed. However, the main aim is to link naval activities to the warming at Spitsbergen in 1918 (A).

This paper will summarize some principal seasonal weather phenomena during wartime, as has been done in respect of three of the war winters of WWII. For the following reasons this investigation will not be as detailed as for WWII:

- The link between war activities at sea that led to changes in the weather pattern has been quite extensively manifested during the war winters of 1939-42 (B).
- During the first few months of war in 1939/40, the war machinery was more powerful and acted more forcefully so that the impact of the war on the weather could be identified more clearly (C).
- In WWI the war at sea first started with full momentum in the autumn of 1916, by accelerated use of sea mines, submarines and counter defence measures on a grand scale.

Further details: (A) Spitsbergen Big Warming, 5_12; (B) Three-years-package, 3_31; (C) North Sea Cooling, 2_16.

For these reasons it is easy to conclude that if the study on the weather making process during the war winters in WWII is not accepted, it seems hardly possible to convincingly a similar connection in respect of WWI with

arguments based on conditions observed during 1914-18 alone. That is why this study seeks, through the presentation of the following facts, in addition to the Spitsbergen warming issue, to support the discussion on WWII's impact on regional weather modification during the war winters 1939-1942 and global climatic change from 1942-1980 by cooling.



At least, at this stage of the investigation it should be mentioned that the Baltic Sea was not free of military activities during WWI. For example, the German submarine U-boat (U-26) torpedoed the Russian armoured cruiser *Pallada*, which went down with all

her 600 men on October 11, 1914. Cruiser *Friedrich Carl* sank after striking a Russian mine in German home waters on November 17, 1914¹. For the Baltic Sea peace had gone for four years. The Russians alone laid 52,000 mines during WWI², in a number of locations, most of them in the Baltic. The Germans laid thousands of mines in the Gulf of Finland to prevent the Russian Fleet from leaving St. Petersburg. It is worth noting that the ice cover in the Baltic increased from 1915 to 1917 (see below: Ice conditions).



However, for the benefit of the interested reader some information will be presented in order to enable him to draw his own conclusions or to undertake more research to find further clues. This presentation will therefore be selective to support the general theme of this investigation.

Did Shelling Bring Rain?

Based on available data on the 'war scenario', it was considered reasonable to link the fighting along the Western Front, together with other anthropogenic causes, to the abnormally wet autumn of 1939. Such surmises will not be used here (in respect of WWI) as too little material has been gathered to come to firm conclusions. However, in 1941 Meissner³ categorically denied any connections between artillery barrage and rain-forcing, between war

¹ Woodward p. 167.

² Ledebur, p. 185.

³ Meissner

⁴ Baden

activities and changes in weather. He confirms the importance of nuclei for cloud-forming and that bombing would release gaseous 'nitrate' in the air abundantly, pointing, as an example, to the fact that forest fires can generate cumulus clouds. Nevertheless, Meissner denies any relevance by referring to the big May offensive by the German General Mackensen against Russia at the East Front 1915, during which the weather remained permanently fine, despite very heavy artillery shelling. Meissner concludes that general weather conditions can obviously not be influenced by war activities.

Meissner was obviously not able to link war and rain together. The German attack on Verdun started on 21st February 1916 with a million troops. Verdun, the longest battle of WWI, ended on 18th December 1916. The French Army lost about 550,000 men at Verdun. It is estimated that the German Army suffered 434,000 casualties. About half of the total casualties were killed.

At least the regional country Baden, in the South-East of the battle fields of France/Germany reported eight months as having been very wet, while February, June, July and August had been too dry in 1915. In 1916, only March and May were partly drier than the average; the other 10 months had up to 30 % more precipitation, in the Black Forrest even 50-80% more precipitation than normal⁴.

In Britain June was very cold and dull. Rain was persistent in the east and north, e.g. with about 150 hours rain in Aberdeen and up to 200 mm. July and August were normal but in September a mid monthly depression moved SE down the east coast and then brought rain and gales to many parts. October was wet and stormy with a record daily rainfall for the month of 200 mm. Up to this point, this was the highest daily rainfall ever for the British Isles. December was extremely cold (details: www.personal.dundee.ac.uk). These conditions show principle comparability with the situation in autumn 1939 (A).

Further details: (A) Rain-Making 1939, 2_31.

Air Temperatures

The first two war years of WWI are mentioned nowhere as having shown any erratic weather variations. This does not mean that there were no 'surprises', e.g. the famous icy winter battle in Masuria in 1915, that the New York Times recalled (NYT, 07 January 1942) citing the remarks of German Field Marshall Hindenburg when the German Army fought against the Russian Tenth Army in arctic conditions in February 1915: "Have earthly beings really done these things or is it all but a fable or a phantom?". Leaving this

question open, it needs to be mentioned that all previous years had been ‘normal’ in climatic terms. That situation changed suddenly. The third war year was different. When the seas around Britain became the scenery for a full military struggle, the winter close to England became very cold in a number of regions. Some information and figures relating to a few regions and locations are given as follows:

Germany, 1916/17; deviation from 15 year means, in bracket, °C.

In the coastal sea areas November and December were about 0.8°C warmer than means average.

North Sea area; January-April 1917 were 2-2.5°C colder than average, more pronounced in SW (Island of Borkum);

Baltic Sea; January – April 1917, the most eastern location Memel (Neman) reports: January (-1.5°C), February (-3.7°C), March (-5.5°C), April (-2.6°C).



Frankfurt am Main⁵.

The cold wave in winter 1916/17 was in no way comparable to any of the three war winters of 1939-42, but the winter in Frankfurt was reckoned as having the fourth longest freezing season during the period 1905-41. The following and last war winter of 1917/18 ranks in the middle with regard to the cold period, whereas the next winter of 1918/19 was mild,

particularly in December.

Actually, in Germany, January 1917 was about 5°C colder than the previous two years, but only slightly colder than January 1914.

In Norway, January 1917 was 4-6°C colder than the mean (1841-90), from Oslo to Røros (ca. 200 km north of Bergen); the winter of 1917/18 deviated by minus 1-2°C, with the next winter of 1918/19 in plus (approx. +1°C) (Source: Norwegian official tables). The coldest measured temperature on Spitsbergen until today was -49,2°C, measured in Gronfjorden, March 28th, 1917 (www.npolar.no_“Svalbard Facts”-Site).

Britain at that time was one of the most interesting places for looking for clues for climatic changes. In all coastal waters around the island, mining, minesweeping, and sinking of ships had become daily life experience since August 1914. The severity of ‘destruction at sea’ built up gradually, e.g. the first submarines went into action in summer 1915, sinking, on an average, two ships per day, or 100,000 tons ship-space per month and as much tonnage of cargo. During 1916 some 1,840 mines were swept and destroyed by a flotilla of more than 500 vessels that constantly navigated around 1,000 square miles a day. This, however, could not prevent the loss of 131

⁵ Fischer, Eistage

Extract from „Climate Change & Naval War – A Scientific Assessment 2005
Trafford on demand publishing, Canada/UK © Arnd Bernaerts

merchant vessels to mines in Britain's home waters. The submarines excelled, sinking approximately 1,000 merchant vessels with a tonnage of 1,784,000 in the second half of 1916⁵. One of the most dangerous newly developed weapons in 1916 was the depth charge, weighing 136 kg⁶. During 1916 the war materials became more sophisticated and the activities at sea grew fiercer⁷. The seas were stirred and water was mixed more and more. Presumably the climate reacted immediately, as figures from the British Isles seem to indicate. War winter 1916/17 became extremely cold in North-West Europe and was the only winter in Britain with three consecutive severe months during the last century with a mean below 2°C (Dec. 1916; Jan./Feb. 1917). The Midlands and South West recorded large snowfalls of up to 14 inches, while Ireland experienced blizzard. It was a heavy snow year for the Highlands. The almost complete comparability between war winters 1939/40 and 1916/17 is evident.

Note: The following tables indicate the significance of low temperatures during WWI years in relation to the fairly normal winter values of 1913/14 and the extreme winter values of 1939/40, a winter regarded as the coldest in many decades. Gunton⁸ regarded January 1940 as probably the coldest in 100 years.



British Isles, Table I, 1881-1940, mean temperature (°F)⁹:

December 1916 and December 1917 temperatures are at rank four of the coldest December months since 1881;

January 1917 is the coldest since 1895/97;

February 1917 is (together with February 1902) the coldest since 1895.

Winter	December	January	February	Means
1913-14	41.9	39.8	44.1	41,9
1914-15	40.2	39.7	39.8	39,9
1915-16	41.2	45.6	39.5	42,1
1916-17	37.9	36.3	36.4	36,9
1917-18	38.1	39.3	44.3	40,6
1918-19	44.6	38.8	37.0	40,1
1939-40	39.5	33.4	38.9	37,3

⁶ Piekalkiewicz, p 414.

⁷ Piekalkiewicz, p.502

⁸ Gunton,

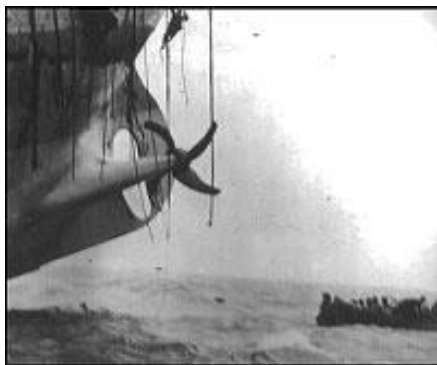
⁹ Glasspoole & Hogg

England and Wales, , Table IA, 1901-1940, mean temperature (°F) ¹⁰;
December 1916 and December 1917 were 2°F colder than the next coldest (1901);

January 1917 was the coldest since 1901;

February 1917 was the coldest since 1901;

The means for three months from December 1916 to January 1917 (108.3°F) is on the same cold temperature level as the first WWII war winter 1939/40 (108.6°F), regarded as possibly the coldest in many decades.



Winter	December	January	February	Means
1913-14	42.1	39.3	44.9	42,1
1914-15	41.4	40.2	40.4	40,7
1915-16	42.6	46.2	39.8	42,9
1916-17	37.3	35.9	35.1	36,1
1917-18	37.3	39.9	44.2	40,5
1918-19	45.8	38.7	36.8	40,4
1939-40	39.2	31.7	37.7	36,2

Scotland, Table IB, 1901-1940, mean temperature (°F) ¹¹;

Winter	December	January	February	Means
1913-14	40.4	38.9	42.2	40,5
1914-15	38.2	38.0	38.6	38,3
1915-16	37.9	43.7	37.8	39,8
1916-17	38.2	36.1	37.1	37,3
1917-18	37.6	36.6	43.0	39,1
1918-19	41.6	37.9	35.1	38,2
1939-40	39.2	33.0	36.4	36,2

Ireland, Table IC, 1901-1940, mean temperature (°F) ¹²;

Winter	December	January	February	Means
1913-14	42.8	41.5	44.3	42,9
1914-15	39.9	40.5	39.7	40,0
1915-16	41.7	46.5	40.4	42,9
1916-17	38.8	37.3	38.0	38,0
1917-18	40.0	41.4	46.1	42,5
1918-19	46.1	40.4	40.3	42,3
1939-40	40.4	37.5	43.2	40,3

Kew Observatory, Table I., Means temperature (°F), 1783-1942¹³;
December 1916 was the coldest since 1891;

¹⁰ Glasspoole & Hogg

¹¹ Glasspoole

¹² Glasspoole

¹³ Drummond.

January 1917 was the coldest since 1893;
 February 1917 was the coldest since 1902;
 The winter seasons (December-February) 1916/17 and 17/18 were both cold.
 One has to go back to 1891 to find an equivalent cold season.
 Winter 1916/17 was on par with winter 1939/40 (cold sum: 109 / 107,9).

Kew Observatory, on the amount of snow in comparison with the cold war winters of 1939-1942;

Drummond writes¹³: Since comparable records began in 1871, the only other winters as snowy as the recent ones (1939-42), were those of the last war, namely 1915-16, 1916-17 and 1917-18, snow falling respectively on 23, 48 and 23 per cent of the days, (figures for 1939-42 are 21, 23, 30); the average (1871-1938) is 9 days per winter months (December -February).

Durham, Table III, mean daily minimum temperature for each month, 1900-1940¹⁴;

December 1916 and December 1917 were the lowest for a decade;

January 1917 was the lowest over the previous decade (1908);

February 1917 was the lowest since 1902;

Means for three months from December 1916 to February 1917 (90.9°F) was only slightly higher than for the WWII war winter 1939/40 (88.6°F).

January 1918 was colder than the previous January (1917).

Observed values in the Stevenson Screen of the mean daily min. temperatures, in °F¹⁵

Winter	December	January	February	Means
1913-14	34.9	33.6	37.4	35
1914-15	33.6	33.5	32.6	33
1915-16	34.1	38.7	31.7	35
1916-17	30.5	32.0	28.4	30
1917-18	31.5	31.4	36.0	33
1918-19	36.1	31.1	29.0	32
1939-40	34.3	23.7	30.6	29,5

Mean monthly temperatures in °F¹⁶

Year	December	January	February	Means
1913-14	39.6	38.6	42.9	40
1914-15	38.3	38.1	37.9	38
1915-16	38.6	44.6	37.1	40
1916-17	35.5	35.0	33.7	35
1917-18	36.1	36.9	41.3	38
1918-19	41.3	35.1	34.1	37
1939-40	38.2	29.1	34.3	34

¹⁴ Manley

¹⁵ Manley

¹⁶ Manley

And with regard to the theme: ‘The Northern Mine Barrage’ (laid near Orkney Island since summer 1918) a distance of about 250 sea miles (500 km), (A), the following figures are worth noting

January 1919 was colder than the previous January (1918);



February 1919 was next to February 1917 the coldest since 1901;

Comparing the four months December-March in winter 1918/19 with the corresponding period in winter 1939/40 the cold number of days is almost equal, 126.4 / 123.3 (-°F).

Comparing the autumn and winter of 1918/19 and 1939/40

(September-March) the relationship in respect of the total number of cold days (-°F) is 245 / 249.4, as against a usual means of roughly 260 in previous years.

At least, the figures given above may indicate that something significant had happened in tandem with the temporary decrease in temperatures. The similarity to the war winter of 1939/40 is obvious. One aspect makes 1916/17 particularly interesting. This particular winter cold in England was not only an appendix to a continental arctic winter, but on a statistical basis, ‘cold on its own conditions’. At that time the Baltic Sea saw much less naval activities and was less ‘stirred and shaken’ by military forces, than prior to the war winters of 1939/40 and 1941/42. This means, the cold was primarily generated in the North Sea.

Another important aspect should be noted. The cold winters of 1916-18 seem to have been without any serious or remarkable erratic or violent weather. This was very different from the conditions during all the war winters from 1939 to 1942. Particularly severe was the ice storm of January 27– 29, 1940. The New York Times gave a general overview of this event (NYT, 28 January 1940), another reference is given by Cave¹⁷. Reasons for this could be found in the larger area the war at sea already occupied as battleground, viz. from Murmansk to the middle of the North Atlantic, and the immediate and greater intensity when the Second World War started in autumn 1939. Compared with this period, the WWI war at sea (1914-18) was closely confined to the seas around the British Isles. And although all these coastal waters are part of currents, permanently moving northwards, the war

¹⁷ Cave

probably was forceful enough to cool the water down quickly and lasting enough before the water disappeared in the Norwegian Current.

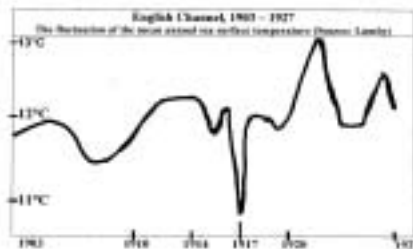
The next section will deal with the cooling of sea surface water.

Sea Surface Temperature

English Channel

In 1935 Lumby¹⁸ published a table showing fluctuations in the mean annual surface temperatures and salinity in the English Channel from 1903 to 1927. From 1901 until 1914 the temperature varied on a narrow band from 11.5°C to 12.2°C. From 1914 to 1917 the temperature dropped to its lowest point of the series, viz. 10.9°C.

This table alone is certainly not sufficient enough to draw any in-depth conclusion. But it is enough to point to the fact that the Kaiserliche Kriegsmarine operated fairly often in the English Channel. The drop in temperature need not be a mere coincident. From Dover to Bournemouth the British had laid numerous small mine fields at most of the approaches to their Channel ports.



To illustrate this point, the text from a following chapter is also given here:

“In September 1916 the U-boat flotilla at Zeebrugge alone sank nearly 50,000 tons of shipping in the Channel, without any hindrance from patrol vessels. It was soon clear that existing methods of combating submarines simply were not working. For example, in September 1916, in one week three U-boats operated in the Channel between Beachy Head and Eddystone Light, an area patrolled by forty-nine destroyers, forty-eight torpedo boats, seven Q-ships and 468 armed auxiliaries – some 572 anti-submarine vessels in all, not counting aircraft. Shipping in the Channel was held up or diverted. The U-boats were hunted but were able to sink thirty ships without having been unscathed themselves.”¹⁹

¹⁸ Lumby

¹⁹ Winton, p.40

²⁰ Gilles

Irish Sea

In 1949 Gilles²⁰ published a graph and table of annual surface water temperatures at Port Erin in the Irish Sea for the period 1900 - 1950, showing a deep decline from 1914 to 1919 as follows:

Port Erin (54°05'N; 4°46'W), Isle of Man, Annual sea surface temperatures in degree Celsius;

1911 = 10.32	1915 = 10.08	1919 = 9.65
1912 = 10.30	1916 = 9.90	1920 = 9.98
1913 = 10.39	1917 = 9.31	1921 = 10.97
1914 = 10.78	1918 = 10.00	1922 = 10.21

The period of low sea surface temperatures fits perfectly with sea war activities in the Irish Sea and the Western Approach during WWI. Actually, the temperatures never dropped below 10°C until 1950, except during WWII. The year 1940 had an annual means of 9.94°C.

The Baltic Sea During the War Years

As there is no immediate indication that the weather during WWI years ran 'out of order' as in the three war winters of 1939/42, no further investigation has been made. Nevertheless, as the work advances it is not impossible to find some 'signals' pointing to weather modification during the years 1914 - 1918 in the Baltic, too. The Baltic Sea had not been left undisturbed. Several ten thousand mines were laid in the eastern part of the sea. A number of fierce naval fighting took place. British submarines operated quite successfully in the area. The extent of ice coverage during winter 1916/17 seems to have similar roots as the extreme ice winters of 1939-42.

As for the winters of 1916/17 and Spitsbergen 1918 it should not go unnoticed that even in the Barents Sea military activities at sea took place, when the Germans laid mines in the White Sea, to make the Russian supply for port Archangels unsafe. British mine sweepers arrived at Murmansk to assist in sweeping, as huge quantities of ammunition, stores and fuel were sent to Murmansk during 1917. And the operations did not go by without losses. One case was the trawler *John High*, which blew up in a minefield in August 1916²¹.

Ice conditions in the North- and the Baltic Sea

²¹ Taffrail, p.198

²² Nusser, Eisverhältnisse

²³ Struebing

According to the assessment by Nusser²² of Germany's coastal waters and based on the number of days with ice observed, the winter 1916/17 ranked 9th among 44 other winters from 1903 to 1947, while 1917/18 ranked 15th and winter 18/19 ranked 17th. In summary none of the three winters shows anything significant. Only the winter 1916/17 is noticeable, but does not match the WWII figures²³. There is little to conclude from these figures.

With regard to the considerable mining in the Central Baltic and particularly in the Gulf of Finland Area since 1914, it is worth noting that the ice coverage in the Baltic Sea, north of latitude 57° North, (island Gotland – Liepaja) increased from one war winter to another:

--in winter 1913 the ice coverage was about 110,000 square kilometres;
 --in winter 1914 the ice coverage was about 120,000 square kilometres;
 --in winter 1915 the ice coverage was about 190,000 square kilometres;
 --in winter 1916 the ice coverage was about 330,000 square kilometres;
 --in winter 1917 the ice coverage was about 400,000 square kilometres;
 --in winter 1918 the ice coverage was about 160,000 square kilometres;
 --in winter 1919 the ice coverage was about 150,000 square kilometres;
 The maximum ice cover possible north of latitude 57° North is 420,000 square kilometres. This coverage was observed only in 1940 and 1942 after 1917. The ice winter of 1917 ranked 3rd since 1894²⁴.

For the purpose of comparison some figures relating to ice conditions in Danish waters are given below
 (number of icy days):

1910 (5.7); 1911 (2.4); 1912 (31.5);
 1913 (7.4); 1914 (6.0); 1915 (6.1);
 1916 (7.3); 1917 (44.9); 1918
 (15.3); 1919 (11.6)²⁵.

In summary, it is not a mere probability 'out of the blue' that military activities in the Baltic Sea during the war years 1914 to 1918 contributed to the ice conditions in the northern part of the Baltic.

Ice conditions at Spitsbergen

Between 1900 and 1914 ice conditions were moderate to heavy



²⁴ Leppaeranta

²⁵ Amtlich, NN

²⁶ Weikmann

but changed to very heavy with the first WWI winter of 1915 and remained so for the next two war years of 1916 and 1917²⁶. The winter of 1915 is regarded as one of the heaviest known, allowing only 50 days of shipping under severe conditions, in place of about 100 days in previous years. Particularly ‘extraordinary ice conditions’ for shipping were observed at the Boar Islands (mid-way between North Cape and Spitsbergen). In 1916 the west coast of Spitsbergen was blocked by ice; Boar Island was ice-free until October 1916 due to predominant NE winds. In 1917 the ice conditions in the Barents Sea were inconvenient, the ice border was unusually far south, occurring rarely and was therefore difficult for transport ships.



Conclusion

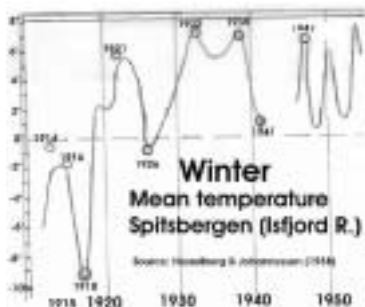
Even a very short review of some principal weather conditions during WWI indicates that this period still may hold a number of clues to link certain weather conditions to activities of the war machinery at sea. The most striking aspects are the significant cooling of Britain in winter 1916/17 to a quite close level as in the arctic winter of 1939/40, continuing until the end of the war and also matching sea ice conditions in the northern Baltic Sea. However, what is most striking are the highly simultaneous snowing conditions in SE England during WWI and WWII, having all the ingredients in proof of the thesis, that the war at sea had modified the weather in a very significant way. A further hot topic is the cold sea water in the English Channel and Irish Sea.

Spitsbergen heats up – Big Warming 1918 (5_12)

Warming process started around 1880

A severe rise in temperature occurred out of the blue north of the European continent in 1918. With the end of the Little Ice Age (~ 1850), and after Krakatoa's volcanic dust had disappeared from the global skies (~ mid-1880), global temperatures had started to rise significantly and steadily. The turn to warming can be largely attributed to less and almost insignificant volcano activity since the second half of the 19th century. Had the earth been free of any industrialized civilisation, the temperatures would have risen constantly. This process would have been reversed one day, when a mighty volcano, meteorite or an oceanic current change would have altered the course of the climate towards a colder world. But the earth has a civilisation that may have interfered. And it did. A number of states waged a war at sea in Northern European waters from 1914-1918. Suddenly the temperatures at Spitsbergen received a big boost. The Norwegian Arctic island Spitsbergen had the same air temperatures as Berlin in January 1919. Had that been caused by a war at sea taking place further in the south? The answer will be 'yes'. The question is only how did it happen and how to prove it?

Rise in temperatures



The armistice had just been signed in November 1918 when Spitsbergen experienced an extremely warm winter. First World War activities at sea seem to have initiated a significant shift in the climatic patterns in the northern North Atlantic. Suddenly the temperatures made a jump. The change was so pronounced that the scientific community spoke of the 'Greening of Greenland'

during the 1920s and the 'Warming of Europe' for two decades thereafter. All that stopped with the commencement of WWII. In 1940 the global mean temperatures stopped rising and in some areas even dropped considerably. This also seems to have drained away the interest in identifying the reasons for the 'Warming of Europe' in the 1920s and 1930s.

Searching for reasons for this warming in the Northern North Atlantic is the aim of this paper. To achieve this objective it is proposed to focus attention on the location where the warming started. Once the location is reasonably identified, it makes sense to look for causes, either precisely identify a cause or proof or rule out any cause and conclude that everything happened by sheer coincidence.

Secondly this paper proposes to focus the attention on identifying the region that served as a cradle for the climatic change from 1918 until the start of WWII, with the aim of linking the war at sea in the North Sea and Britain's Home waters to the climatic change. Spitsbergen, the region particularly in focus, is halfway between the North Pole and the North Cape, and about 2,000 km north of Scotland. North of Spitsbergen the North Atlantic ends.

WWI had hardly ended in November 1918 when high in the northern hemisphere a change of great significance occurred. An accelerated warming of the air temperatures occurred high up in the northern North Atlantic. In the 1930s a number of scientists mentioned this fact in more or less general terms. They will be mentioned first. In subsequent sections a brief presentation of the general temperature developments during the pre-WWI decade and in a further section a detailed description of the data records at Spitsbergen and the wider region from about 1914-1922 are given.

Focus on Spitsbergen

One of the first to point to the extraordinary temperature developments at the 'Green Harbour' Spitsbergen station was the Norwegian scientist B.J.Birkeland¹ in 1930. He was very surprised at what he discovered. He finishes his brief essay: "In conclusion I would like to stress that the mean deviation results in very high figures, probably the greatest yet known on earth". A couple of years later, in 1936, Johannsson (Helsingfors) and Scherhag (Hamburg) put Birkeland's findings into a wider context.

Johannsson² considers the recent temperature conditions at Spitsbergen with reference to Birkeland's research from 1930. Although Johannsson focuses his investigation on the relevance of sun-spots, some general findings are nevertheless interesting, for example:

- In 1919 the statistical means crosses zero-value; or in other words, all previous years are colder, all later years are warmer (p. 86).
- The climate had become more maritime (p. 86).
- Between 1917 and 1928 the increase during the summer season is +0.9°C per 10 years, and in winter +8.3°C, in February +11.0°C (p. 87).
- There was a colder period from 1912 to 1917 (p. 90), which, had this not occurred, would have resulted in a 1.1°C increase at the Green Harbour Station (p. 91).

¹ Birkeland

² Johannsson

- As is known, the winters in Europe over recent decades (after 1880, even more since 1900) have become milder, the climate more maritime, the annual temperature means higher (p. 91).
- It seems that the changes are coming from the North, but this is not necessarily confirmed by temperature observations at some stations (e.g. Stockholm, Edinburgh), showing a warming from 1876-1920, but not later (p. 91).
- Temperatures in North Norway show no change between 1891-1905, but a +0.4°C change between 1921-30 (in Svalbard, 2.5°C), indicating that the increase in N-Norway is only delayed, and presumably also in Svalbard (p. 91f).

Johannsson's main conclusion is that the increased air circulation (15 % higher) between 1896 and 1915 had gradually changed the current and ice conditions, thereby altering the borders between the Arctic gulf current climate and the true Arctic climate further north.

Scherhag³ discussed in his paper of 1936 the extraordinary increase in the winter temperatures in Greenland, concluding that this was caused by a considerable retreat of the ice border and the prominent increase of the atmospheric circulation⁴. Concerning the situation at Spitsbergen in 1919, he only refers to Birkeland's work from 1930, as stated above. In 1938 Brooks⁵ pointed to the anomaly in Scherhag's assertion on increased circulation: Attributing the recent period of warm winters to an increase the in strength of atmospheric circulation only pushes the problem one stage further back, for one should still have to account for the change in circulation.

Scherhag⁶ states that a thorough research on changes in temperatures over the whole northern half of the globe over the years 1921 to 1930 confirmed that the largest part of the region investigated had indeed been considerably too warm during the decade 1921-1930. Scherhag stressed that "such kind of climate change as could now be observed in Spitsbergen and along the western coast of Greenland were certainly not restricted to a small region but must be global"⁷. In his subsequent research paper Scherhag also pays little attention to the situation at Spitsbergen in the late 1910s, merely acknowledging that the extent of the temperature increase would doubtlessly be greatest in the Arctic⁸.

³ Scherhag, Nordeuropa

⁴ Scherhag, Nordeuropa

⁵ Brooks

⁶ Scherhag, Arctic

⁷ Scherhag, Arctic

⁸ Scherhag, Milderung

⁹ Kelly, et.al.

Kelly et.al.⁹ concludes: Concerning the average temperatures in the Arctic (65°-85°N) a warming of 1.6°C occurred between 1917 and 1921, with the maximum reached in the 1930s. Rapid warming affected the Arctic during the late 1910s and 1920s, with the average temperature peaking during the late 1930s.

There are a number of other research papers dealing with the warming of the Northern Atlantic since the end of the 1910s, which will be discussed in another chapter: Warming of Europe. All pre-WWII papers acknowledge the suddenness of the rise in temperatures in the North Atlantic region since the early 1920s but make little use of the hint given by Birkeland in 1930¹⁰ (see: above) that something extraordinary happened in Spitsbergen at the end of WWI.

Spitsbergen Temperatures 1912 – 1926

To find out at what time exactly the climatic changes of the 1920s started, the following discussion considers the core winter months of December to February, if not stated otherwise. As explained elsewhere, tracing the sources of ‘climate making’ is much easier if the sun is not involved. Without the sun heat from the oceans is the sole sustainer of the weather mechanism in wintertime at high latitude. Concerning the summer 1918 at Spitsbergen Weickmann¹¹ reports that the water in the Fjords of Spitsbergen west coast had been very warm, 7-8°C. WWI had still a couple of months to go.



¹⁰ Birkeland

¹¹ Weickmann

¹² Manley

¹³ Birkeland

A very clear demonstration of the rise in temperature during winters in the North is given by a graph of temperature developments in Norway from 1871–1938, prepared by H.W. Ahlmann and reproduced by Manley¹², showing the changes in the ten-yearly winter mean temperature in Norway (Tromsø, Røros, Bergen, Oslo) and Spitsbergen. The most interesting aspects of the changes indicated is the time of commencement of the rise, showing that the turning point was later in the South as in the North: Spitsbergen before 1920; Tromsø in 1920, Røros, ca. 1921-25; Bergen and Oslo, 1924-25.

As mentioned earlier, the information given for Spitsbergen (Svalbard) by Birkeland in 1930¹³ was already a quite sufficient indication of the suddenness of the temperature shift. Some figures are reproduced:
Deviation from monthly means based on average means for January: 16,09°C; February 19,09°C (1912-1926);

Year	Annual deviation	January Deviation	February deviation	Sum of Jan-Feb	
1912	-3.1	-8.4	-7.3	-15.7	
1913	+0,2	+0.3	-1.7	-1.4	
1914	-1,3	-5,7	-4.9	-10.6	
1915	-2.0	+1.8	-0.5	+1.3	
1916	-2,5	-8.6	+2.1	-5.5	
1917	-5.0	-7.4	-10.3	-17.7	
1918	+0.1	-10.1	-0.4	-10.5	
Mean deviation per winter months Jan., Feb.: - 4,3					
1919	-0.8	+8.6	-4.7	+3.9	
1920	+2.3	+3.8	+1.4	+5.2	
1921	+0.6	-0.8	+0.1	-0.7	
1922	+2.5	+10.5	+6.9	+17.4	
1923	+2.9	+3.3	+4.8	+8.1	
1924	+2.5	+5.7	+8.1	+13.8	
1925	+1.9	+4.3	+6.3	+10.6	
1926	+0.8	+2.2	+0.5	+2.7	
Mean deviation per winter months Jan., Feb: +3,8					

As already mentioned¹⁴, the change came suddenly. On the basis of half a dozen years the jump before and after winter 1918/19 is about 8°C. Comparing only January/February of 1917 and 1918, with January/February of 1919 and 1920 the temperature jump is almost plus 10°C.

¹⁴ Johannsson

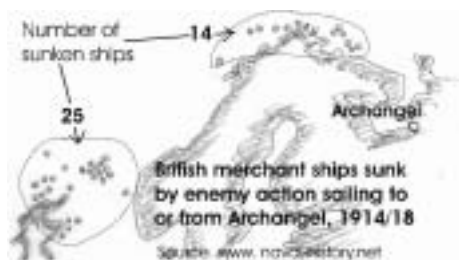
During the winter of 1918/19 the temperatures varied much. There were long periods in November and December 1918 with close to zero degrees (approx. 26 days less than 5°C), with 4 days above zero in November and 7 days in December. In January 1919, on 14 days the temperatures did not reach -5°C, five days were frost-free. With average monthly temperatures of -7.47°C and +8°C, respectively, above 15-year means the sea must have transferred a lot of heat to the air. However, during February – April 1919, the temperatures were well below the average with a large ice cover far out into the sea. But that did not affect the significant warming that started a few months earlier.

One further point needs to be observed. Actually, the ‘warming-up’ process must have started some months before winter 1918/19. The annual deviation for 1918, i.e. “+0.1”, indicates the end of a cooling trend since 1915, during the previous winter 1917/18, sometime in spring or early summer 1918. The warming at Spitsbergen started in 1918. The ‘warming processes’ must have started within a short period of time, definitely not before 1916, and the ‘Severe Warming’ at Spitsbergen not later than winter 1918/19. During that time the war at sea in English waters had been going on and the first mines of the Northern sea-mines barrage had just been laid when temperature data records started indicating a sharp rise (A).

Further details: (A) Sea mines warfare 1914-18 (5_14).

As the ‘rise’ sustained for two decades only, the seas, by a substantial shift of the seawater bodies around Spitsbergen and the Northern Seas could have generated such long-term climatic changes. This section could establish with high reliability, that a colossal temperature rise occurred in the Spitsbergen region from summer 1918 to winter 1918/19.

Cause for the rise in temperature



The questions on the causes for the temperature increase at Spitsbergen in 1918 can partially be answered very decidedly. The heat must have been generated in the eastern part of the Norwegian/Greenland Sea,

either due to internal processes within the water bodies, or by ‘more’ warm water from the Atlantic Gulf current. The latter came with the West Spitsbergen Current after it had travelled as the Norwegian current from the Hebrides Islands northwards and continuing as the North Cape Current to the Barents Sea.

Once the warm Atlantic water is north of the Hebrides and Iceland matters get very complex. The availability of large and deep-water bodies is the ultimate ‘blueprint’ for the Northern Hemisphere climate.

But the most remarkable aspect of the ocean system with all its idiosyncrasies is the miraculous stability, which the system has. Everything fits together, and nothing changes without a cause. And the fact that nothing changes in the ocean system without a cause also applies fully to the sudden rise in temperature at Spitsbergen 1918/19.

How the ‘Severe Warming’ happened in detail is completely out of the purview of this investigation. This paper only aims at reiterating the responsibility of the war at sea for the dramatic warming event in the Spitsbergen area and the ensuing climatic change during 1919-1939. After all, the war at sea ‘moderated’ the common temperature and salinity structure of huge sea areas and sea bodies over many seasons. Billions of tonnes of water from Britain’s coastal areas and the North Sea flow northwards to the Arctic region. This water could ‘in one way or the other’ have changed the hydro-physical feature, e.g. sinking quicker, freezing later, etc. For this purpose some thoughts on making and sustaining a Severe Warming are outlined in the following four scenarios.



Scenario 1: A considerable part of the Atlantic water moves via currents to the basin of the Arctic Ocean (max. depth 4,000 m). Actually, due to the high salinity of the Atlantic water and the cooling process, the water becomes very dense and ‘falls’ over a ridge (with a depth of 600 m below sea level) in the Arctic Basin. Before the Spitsbergen current

reaches the ridge, at about 80° North, the water at a depth of 20 metres has a salinity of about > 35 per mille and a temperature of up to 7°C¹⁵.

Schokalsky¹⁶ states: The warming of the polar region started in 1921. This is presumably due to the fact that the arm of the North Atlantic current that enters the Arctic Ocean at the edge of the Spitsbergen continental shelf had increased its strength. The cover layer of cold water, which had been 200 metres in the 1890s, was reduced to less than 100 metres in the 1920s.

¹⁵ Knies

¹⁶ Schokalsky

More, quicker and closer to the sea surface the warm Spitsbergen Current carries water along the island Spitsbergen to the Arctic Basin, the warmer it will become there and in the Arctic region, and winter icing will be less. Such a situation might have contributed significantly to the severe warming in 1918, but could hardly be the sole source for the sustained warming over two decades.

Scenario 2: The North Cape Current, which supplies the Barents Sea with Atlantic water, may have contributed to the warming in the long run. But generally speaking, the Atlantic water ‘disappears’ in the East of the North Cape and Spitsbergen. Instead a polar water current flows in from NE and partly joins the Spitsbergen Current in the south of Spitsbergen. According to Wagner¹⁷ the mean water temperatures in the Barents Sea increased by +1.8°C from 1912/18 to 1919/28. From 1916 to 1925 the annual mean water temperature was as follows¹⁸:

1914 = -0.3°C	1915 = + 0.7°C	1916 = -1.1°C	1917 = -1.5°C	1918 = -1.6°C
1919 = + 0.6°C	1920 = +1.0°C (?)	1921 = +1.0°C	1922 = +1.9°C	1923 = +1.0°C

Wagner’s additional observations confirm a ‘rise of 2-3°C at water depths of 100 and 200 m over the last 30 years (1895 and 1927). However, a general observation of ‘over 30 years’ is of little help in this case.

It is not easy to assess how much the only up to 500 m deep Barents Sea might have contributed to the ‘Severe Warming’. Presumably not very much during 1918, although the Barents Sea ice border retreated significantly since 1919¹⁹. On a 10-year mean basis (1911/20 and 1921/30) a significant increase of 6°C at Franz-Joseph Land was observed²⁰. After all, a complete renewal of water body of the Barents Sea is completed in every four years²¹. Thus, the Barents Sea would require a permanent water inflow, which could only come from the South when it is supposed to sustain warming. According to Lamb²², the highest water temperatures in the top 200 m of the Barents Sea at 70-72°N; 33°E, north of the Kola peninsula, already appeared to have been reached during the period 1935-39.

After all, the Barents Sea may have contributed to the warming of Europe from 1918-1939 on the basis that the sea received warm water and changed something of its internal processing, different from previous years.

¹⁷ Wagner, p.50

²⁰ Kirch

¹⁸ Wagner, Tabl.10

²¹ Schokalsky, p.71

¹⁹ Wagner, p.47

²² Lamb, p.528

Scenario 3: West of Spitsbergen the seawater has temperatures of 5°C and a salinity of 34.90 –35.00 mg. A big part of the warm Atlantic Gulf water that has reached Spitsbergen, ‘turns left’ in southwest direction at position 75-77° North and flows either as Greenland current down to Newfoundland and back in the Atlantic or goes down the huge Greenland Sea Basin with depths of 2,000 metres and more (max. ca. 3,500 m), or circles for some time with the surface water layer or the thermocline waters. This water may have contributed to the warming at a later period of time on a long-term basis.

Scenario 4: At fourth place is the Norwegian Sea Basin with depths of 3,000 metres. The whole eastern part of the European North Atlantic – Norwegian Sea - is a reservoir for Atlantic Gulf water going to depths of 800 metres. This water body has a huge heat retaining capacity. Any increase in temperature, or enlargement of the ‘warm water part’, or ‘its functioning’, would quickly be reflected in temperatures at Spitsbergen, in Europe, or elsewhere in the Northern Hemisphere. In addition, while the deep water of this basin is formed north of Jan Mayen, it can, in exceptional circumstances, by any means, warm Atlantic water that is ‘pushed down’ to lower depths after passing the Shetland Islands, Faroe Island and Iceland ridge (approx. 500 m). This water then remains in the Norwegian Sea for some time, until ‘the time has come’ for increased heat, which reaches the sea surface again to be released into the atmosphere. The war at sea could have caused the Norwegian Sea to increase its heat storage during the war years 1914-18.

This ‘restructuring’ of the sea body by the war at sea could also have led to an increase in the inflow of warm water²³; whereby in a section crossing the Norwegian Atlantic Current, a very marked change occurred in 1928, when temperatures and salinities had relatively much higher values than previously observed. From May 1927 until May 1929 a dynamic calculation showed an increase in the masses of ‘Gulf Current’ streaming northwards to the Norwegian Sea of about 20%.

As an interim summary it can be said that the temperature rise in 1918 may have been generated by three of four possible causes as mentioned above. For the subsequent climatic change from 1919 to 1939 the Norwegian Sea presumably had been the core contributor.

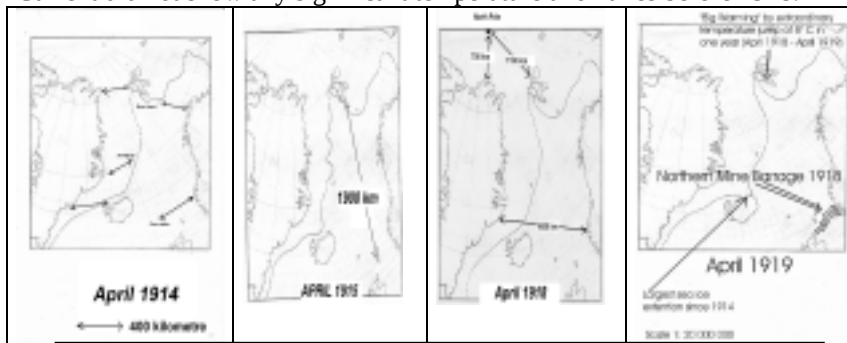
Sub polar North Atlantic

The North Atlantic from Canada and the United States to the shores of Great Britain and France can be definitely excluded from those causes which have contributed to the severe warming at Spitsbergen. In this connection, reference is made to the information relating to the impact over the time after

²³ Helland-Hansen

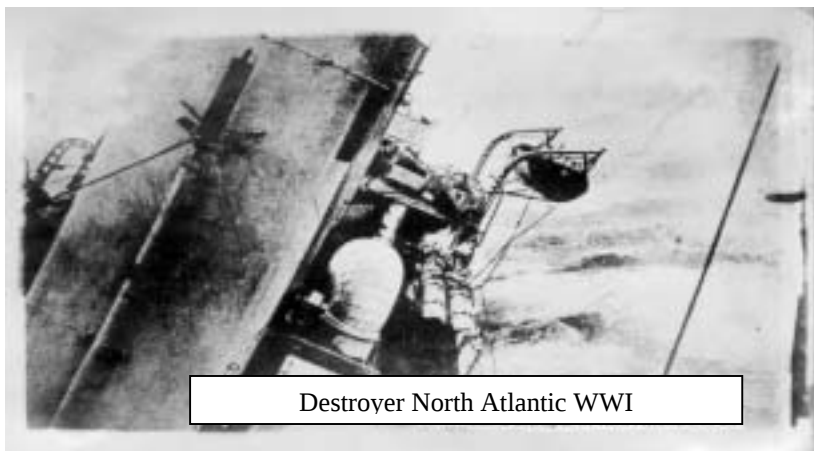
*Extract from „Climate Change & Naval War – A Scientific Assessment 2005
Trafford on demand publishing, Canada/UK © Arnd Bernaerts*

1918, (see below; chapter Warming of Europe 5_15), indicating that the Gulf Current did not show any significant temperature anomalies before 1918.



Sea ice extension in Northern North Atlantic during World War I

A ‘manipulation’ of the Gulf Currents during WWI while passing the Faeroe Ridge can certainly not be excluded from the causes, at least for the Severe Warming in 1918. However, to sustain the warming for two decades, further ‘modifications’ must have occurred in the various water bodies north of the Faeroe Islands as well.



Destroyer North Atlantic WWI

Previous research and analysis

Weickmann²⁴; At +7-8 °C, the water temperatures in the Spitsbergen Fjords on the west coast were very warm in summer 1918!

²⁴ Weickmann

²⁵ Manley

²⁶ Henning

Extract from „Climate Change & Naval War – A Scientific Assessment 2005
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Manley²⁵: The effect was indeed remarkable; the salty Atlantic water penetrated further into the Arctic to such a degree that, for example, the average length of the coal shipping season at Spitsbergen almost doubled in length, from 95 days during 1909-12 to 175 days during 1930-38.

Henning²⁶: Before 1917 the duration of shipping to Spitsbergen had averaged 94 days but since 1918 –1939 it had become 157 days. The warming moved the vegetation in Scandinavia some 100 km further north.

Schokalsky²⁷. The discovery concerning the warming of the Polar Sea, which dates from 1921, was also observed by the 1928 *Marion* Expedition in the Baffin Bay as well as in the Barents Sea.

Kunz, G.²⁸ dates the temperature shift at Spitsbergen to 1918, based on the



WWI depth charge secured & in action

winter ice conditions around Spitsbergen, noting that after the very ice-rich years of 1915-17 the subsequent years since 1918 had most been ice-poor.

Brooks²⁹: At Spitsbergen at least, the rise occurred in two stages, the winters of 1922-23 to 1924-25 being warm, those of 1925-26 to 1929-30 somewhat cooler, and those of 1930-31 onwards warmer than the first group.

Summary

Every aspect elaborated above with regard to the warming at Spitsbergen indicates that it was not a common meteorological event, but a 'Severe Warming' in terms of climatic change. The change was not only severe but also lasted for two decades. That is

²⁷ Schokalsky

²⁸ Kunz

²⁹ Brooks,

possibly even not less remarkable. The shift could evidently be dated to have happened from about summer 1918 to spring 1919, whereby January 1919 with mean temperatures $+9^{\circ}\text{C}$ above average definitely marked the turning point. January 1919 is presumably the only major climatic change event in recent times that can be dated with such precision.

The big shift remains extraordinary even considering that the period 1915-18 had been relatively cold. The rise remains remarkable even if the cold war period of 1915-18 is reduced to the general warming trend since the 1880s. The shift in 1918/19 would still be “probably the greatest yet known on earth” as Birkeland saw it in 1930 (see above).

The ‘Severe Warming’ occurred in very close correlation with the war at sea waged only 2,000 km further south from where the ocean and North Sea waters need only 2-3 months to be carried by the Norwegian and Spitsbergen Currents to the Arctic region. The war at sea in Europe had shifted to high gear since winter 1916/17. This could have changed the structure of water bodies and currents over huge areas. The Northern Sea Mines Barrage laid in 1918 could have provided the ‘last straw’ for the warming, which showed its appearance in summer 1918 with extraordinary warm water temperatures in the Spitsbergen Fjords³⁰.

After all, the ‘Severe Warming’ at Spitsbergen in 1918 did not come from “nowhere”, nor did the subsequent ‘climatic change’. The war at sea from 1914-18 unleashed forces, that were presumably mighty enough to cause a severe warming at Spitsbergen.



Sinking battleship

³⁰ Weickmann, FN 11

WWI warms up Spitsbergen? (5-13)

A Big Warming started 1918



In a separate paper it was concluded that WWI was not necessarily 'neutral' concerning the weather. Particularly Britain, surrounded by naval warfare over four years, showed strong indication that its weather had been influenced by numerous

military activities at sea as far as temperatures and snowfall were concerned. Temporary weather modification seemed to be evident.

This paper shall go beyond the question of weather modification. This paper further proposes to look for clues that may explain why a sudden, extreme and lasting warming occurred in the high North of the North Atlantic, as recorded at Spitsbergen since 1918. This 'Severe Warming' in the North led to the first significant climatic change during the 20th century, lasting for twenty years until the winter of 1939/40. The second dramatic climatic change during the last century started 1939/1942. The Severe Warming at Spitsbergen 1918 and the continuation thereof must have a cause. There was nothing around Spitsbergen, in the East, the North and in the West, that could have initiated such a sudden rise in temperatures at Spitsbergen. The only pathway to receive temperature-generating masses was the ocean water coming from the South, via the Spitsbergen Current and the Norwegian Current, but at the beginning of these currents lie European coastal waters.



These waters around the Isles of Britain, composed mainly of the warm Atlantic Gulf Current, had been the principal sea battlefields since World War I had started in August 1914.

The following presentation shall provide a basic idea of the forces and destruction that had been unleashed over a relatively short period of time. The forces had been so huge that one can go on saying: No drop of water of

the Western Approach (Ireland, English Atlantic coast), the English Channel, and the North Sea from Dover to Shetland Island had been left unturned. This water from the battlefield eventually flowed northwards with the currents. The composition and temperature structure of the seawater that arrived in the North was no longer ‘natural’. Considerable parts of the water had flowed into the Arctic Basin; other parts may have circled in the Northern Atlantic (Norwegian Sea) for many years. This section provides the necessary information on how extensively the war machinery interfered with ocean and seas, water and the current system. As no other reason has ever been convincingly named for the sudden warming at Spitsbergen in 1918, and as the warming remained stable for two decades, the water at sea in Western Europe as the basic cause for this warming is an extremely plausible explanation.

Structure of the paper

Although WWI lasted for four years, the war at sea went into full gear only in autumn 1916. The Germans had recognised the power of the U-boat as the most effective naval combat vessel. Both the British and the Germans realised the need and equipped themselves for sea mine warfare. The British also returned to the 19th century concept of a convoy system and had a newly developed anti-submarine technique at hand, viz. the depth charges. The war reached its highest stage in 1918, when a huge sea mine barrage was laid at the northern entrance of the North Sea.



To meet the objectives of this paper, relevant naval information and features will be provided under the following two sections:

- The period from 1914 – 1916 will give some general impressions on the situation.
- The period from 1917 to the end of the war in November 1918 will

particularly focus on the enormous destruction to man, materials and the radical turning about of the seas by the war at sea.

A later chapter will deal with sea mines and the Northern Barrage.

This paper is not a historical naval warfare account, nor does it aim at being complete. Further facts should be obtained elsewhere by interested parties.

The war period 1914 – 1916

Weather protects impertinent attacker

German battle cruiser bombards North Yorkshire's coast, 16 December 1914: The story is about weather-making by naval forces in combat missions at sea and is taken from the book 'Swept Channels'¹. The narrative tells the story of a German battle-cruiser bombarding Hartlepool, that had a battery of guns, and Whitby and Scarborough, that had not, shortly after daylight on December 16, 1914. That left 120 people killed, and over 400 wounded. A German Communiqué short time later reports about "parts of our naval forces", but does not name the vessels involved. It was claimed that one English cruiser was destroyed, others damaged². Further details are given below:

"The whole story is told by Mr. Winston Churchill in the *World Crises, 1911-1914, Vol. I, p. 467*. Squadrons and flotillas were moved to deal with the expected raid, and these forces actually made contact with the enemy during their retreat and opened fire. At one point the British and German battle-cruiser forces were only twenty-five miles apart, and were still closing in on each other. Further seaward there was a powerful battle squadron under the command of Sir George Warrender. The action was imminent, and it could only have one result.

Then, as it so often had happened before, the weather supervened. The wind sprang up and the sea started to run high. The North Sea mist came down until the horizon became blotted out in a curtain of thin vapour. The weather gradually thickened, the visibility dropping from 7,000 to 5,000 yards, then to 3,000. In the driving rain-squalls the area of vision was bounded by a circle whose radius was sometimes less than a mile.

Between fifteen and twenty heavy ships, and a number of light cruisers and destroyers, all steaming at high speed, were groping for each other within a space of about sixty square miles. Their wireless signals could be overheard in Whitehall, where their positions were constantly plotted on the large chart in the War Room at the Admiralty. It was like a nerve-racking game of Blind Man's Buff played in the dark, with huge ships instead of children – and the enemy escaped."

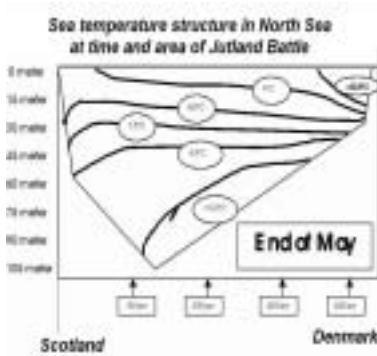
REMARK: The sea area mentioned is off the coast between the lighthouse Flamborough Head and Newcastle. In a short distance from the coast the water depth reaches 60 metres and more. In December the means temperature of the water body is almost homogeneous at about 8°C.

¹ Taffrail, p.92.

² Piekalkiewicz, p.138.

The surface layer may already have been considerably cold. Possibly a number of four dozen big ships moving fast around and shelling at each other, is as effective as the spoon in the hot soup cup, stirring nervously. Encounters, as at Hartlepool in December are the way naval forces can influence weather.

Battle of Jutland – May 31, 1916



In naval history presumably nothing has so extensively been documented and described as the Battle of Jutland in May 1916, and no action of any two commanders has been more painstakingly analysed concerning strategy and leadership. In most general terms one possibly could say the outcome was at on par.

What has not yet been considered is whether it was reasonable to have mobilised such a huge armada of naval vessels against its enemy at the time of the year and at the location in the first place. Actually, in all respects the encounter was neither won nor lost by any of the combatants due to dust, mist and later fog. Neither of the fleet leaders, the Admirals Jellicoe and Scheer, had been prepared for this. Either of the Admirals could have won the battle if he had been advised that such a huge armada of ships, fighting and moving, would inevitably reduce the visibility in the sea area very quickly to the lowest level, by dust, mist or fog.

By the end of May, 1916 the air is already warm, so also the upper sea surface, while the lower water body is still cold. Cold water pushed to the sea surface initiates condensation in the air above the sea surface. Consequently visibility is quickly reduced. Since the Admirals had nothing but flag-signals for communication, it seems they did not foresee that such huge armada would cause bad visibility, and as such they had not been prepared for it in advance. In other words, they should either have known in advance how to 'manage their flotilla' if haze arises, or how to avoid the trap. 250 big vessels crisscrossing the sea at high speed in the middle of the North Sea by the end of May was worth a big bet with high certainty that mist and fog would rise from the sea surface.

The sea area of engagement was about 50 x 50 square sea miles. 151 British and 99 German vessels with a total number of 100,000 men had been on the scene. 25 ships were lost; loss of life: 10,000 men.

By raising the point of ‘fog and mist’ during the Battle of Jutland may only illustrate that the naval armadas had influenced the weather, and that this presumably prevented one of the two Admirals to win. However, any



influencing the weather beyond the battle will not exist. For climate the biggest sea battle of surface naval vessels in Europe’s waters of all times, will have passed unnoticed. But not so many thousand naval activities every day as long as the war lasted.

Tanker ‘Conch’ torpedoed - December 1916

Down in the English Channel, the tanker *Conch* loaded with 7,000 tons of benzene was torpedoed, which burned like a giant torch. The explosion blew the after-tank top off and showered the bridge and superstructure with blazing oil. Engines were kept running to prevent blazing oil from collecting round the ship. Steaming onwards, unmanned but still blazing furiously, she foundered next morning³.

Naval warfare 1914-1916

The German Navy had 28 U-boats when the war started in August 1914. Their capacity was limited. By February next they had lost 7 U-boats but had sunk 10 vessels with a total tonnage of 20,000. This figure accounted for only 10% of all British losses during the first six months of war. Mines sank double that figure over the same period.

The tonnage available with the Allies and neutral countries was estimated at 40 million tons. By January 1917, 5 million tons had been sunk, but 4.4 million tons were built new.

By the end of 1915 Britain had lost 845,000 tons, 90% of which by U-boats. This is almost two ships per day. At that time 20 U-boats had been sunk. The first depth charge, actually a converted mine that detonated automatically at about 15 metres depth had been deployed in 1915. In June 1915 a new depth charge with 300 pounds TNT or amatol had been developed and was used since January 1916⁴.

³ Winton, p.46.

⁴ Winton, p.34

Early 1916 saw some political wrangling about U-boat warfare, which was resumed with new boats in August. A brief excerpt from Winton⁵ is reproduced below with respect to the cold winter of 1916/17 in South England:

“In September 1916 the U-boat flotilla at Zeebrugge alone sank nearly 50,000 tons of shipping in the Channel, without any hindrance from patrol vessels. It was soon clear that existing methods of combating submarines simply were not working. For example, in one week of September 1916 three U-boats operated in the Channel between Beachy Head and Eddystone Light, an area patrolled by forty-nine destroyers, forty-eight torpedo boats, seven Q-ships, and 468 armed auxiliaries – some 572 anti-submarine vessels in all, not counting aircraft. Shipping in the Channel was held up or diverted. The U-boats were hunted. They sank thirty ships, and were entirely unscathed themselves.”

REMARK: A similar situation can be assumed in a number of critical sea areas, particularly in the Western Approaches and the Irish Sea. If one assumes that each of the ‘anti-submarine vessels was using one depth-charge per day and was at sea for five hours per day, the waters around Britain were not only ‘stirred’ but ‘shaken’. Actually, many mine sweepers, trawlers were also used as patrol boats and had practically no rest time⁶.

During October 1916 U-boats were able to sink 300,000 tons. The average tonnage sunk during 1916 per month was ca. 190,000 tons.

From August 1914 until December 1916 the U-boats sank 2,200,000 tons. This represented a total number of 1,660 Allies’ vessels⁷. However, this was only one quarter of a further 9 million tons the U-boats had sunk in the next 22 months.



So much extraordinary naval activities around the British Isles was a huge invitation to continental air masses to move freely to England and take reign during winter 1916/17 and bring about successive snow winters from 1916-1918.

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⁵ Winton, p.40 ⁶ Taffrail, p.20 ⁷ Potter, Nimitz, Rohwer, p.437

Naval Warfare 1917-1918

General impact

The situation became dramatic for Britain in early 1917. U-boats sank more ships than new ships could be delivered by shipyards. In April 1917 almost the annual rate of the previous years was reached with 860,000 tons. During the year 1917 U-boats alone sank 6,200,000 tons. This amounted to more than 4,000 ships

Since early 1917 the Allies had introduced the convoy system, whereby naval vessels escorted a number of ships, roughly 20 to 30 ships in a convoy. Sailing in convoy proved quite safe for the ships, although the Germans could put up to 50 boats in operation in July 1917, and built an additional 30 boats per month. The USA had entered the war in April 1917. More than 2,000,000 men were sent to Europe during the coming months.

During the year 1918 until October U-boats sank another 2,500,000 tons, accumulating the total during WWI to 12 million tons. The breakup of this is: about 5,200 merchant ships, 10 battle ships, 18 cruisers, 20 destroyers and 9 submarines⁸. The total loss in naval units, Allies and Axis, was 650 ships (including 205 U-boats) with a tonnage of 1,200,000 tons⁹.

Depth Charges – What it meant to attack a U-boat?



The onslaught by U-boats reached the pinnacle with almost one million tons sunk per month as on April 1917. Although the British Navy was able to prevent

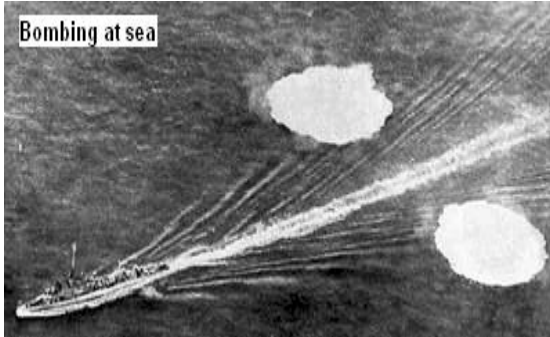
hundreds of attacks, real or suspected, the result was not encouraging. Only a mere 11 U-boats could be sunk in four months. New protection measures

⁸ Potter, p.444

⁹ Piekalkiewicz, p.589

¹⁰ Potter, p.433

such as convoying, patrols and a new most promising weapon, depth charges, etc. were regarded necessary.



The availability of depth charges had been scarce in early 1917. Every ship was equipped with only two depth charges. With the beginning of 1918 destroyers got 30 to 40 pieces

each as supplies increased¹⁰. What that meant for the U-boats is outlined in the following feature, and the same 'story' could possibly have happened in many dozens cases every day.

While U-boats hunted and torpedoed enemy merchant and naval vessels during the early days of WWI without hindrance, the scenario changed since 1916. They became the hunted and were depth-charged. Thousands of naval vessels steamed the seas around Britain day and night. The experience of U-boat U-72 in May 1918 may illustrate the situation at sea. In early May some 75 depth charges were dropped on the boat by anti-submarine vessels and from an airship. Later a destroyer arrived and attacked U-72 with another 20 charges. This caused a leak in a fuel tank leaving a trail of oil at the sea surface. 24 hours later U-72 was again depth-charged by two naval vessels more than 20 times. A British submarine sank U-72 a few days later.

Operating in a sensible area – Around the Shetlands

Another example: U-boats were a problem to the British. In June 1917 its shipping loss rose to over 680,000 tons. For this reason four flotilla leaders, with some 50 destroyers and seventeen submarines were sent to



an area stretching from NW of Stornoway, round to the north of the Shetlands and eastwards into the North Sea between the 15th and 25th June

1917. The idea was to force the U-boats to the surface and attack them. On sixty-one occasions U-boats were sighted and were attacked twelve times¹¹. In practice that presumably meant, that during the operation of 75 naval vessels many hundred depth charges had been dropped, in addition to some shelling. No U-boat was sunk. This episode demonstrates that huge operations in the sea may have taken place, which did not go by without any impact on the sea area. However, these were not accounted for in relation to climate change.

Barents Sea and Baltic Sea

The matter would be worth a detailed chapter but would require some lengths. Although the areas at no time took the centre stage they nevertheless saw immense naval activities and destruction. Particularly the intense encounters in the Barents Sea could have played some role in the strong icing in the high North in February 1915 and the harsh winter in North-West Europe 1916/17. Until early 1915 more than 450.000 tons coal and 90.000 tons weaponry had been shipped to the Russian port Arkhangelsk. Russian and German navies had laid thousands of sea mines, and dozens of minesweepers were permanently in service. U-boats sunk 25 ships in late 1916 and further 21 vessels from April to November 1917.

In the Eastern Baltic Sea many dozen mine fields were laid with some ten thousand mines. Many naval activities took place every day over four years. British and Russian submarines operated successfully. The increasing sea icing over the war years from 1914 to 1918 can be attributed to naval warfare in Baltic waters.



¹¹ Winton, p.70

Summary

Can the fighting around the British Isles during WWI have caused the sudden warming at Spitsbergen in 1918? That is the main question to be answered by this paper and another paper on sea mining 1914-18.

At first, however, the attention is drawn to the ‘weather modification issue’ by referring to the fact, that Britain had very cold winters from 1915-1918 and massive snowfall, only comparable to the conditions during WWII, weather. The compatibility of the conditions on a time scale (according to observations available) comprises the following:

- The value of mean winter temperatures, which match some of those from the record winter 1939/40.
- The extraordinary similarity in years of snowfall, time period of snowfall, quantity of snowfall and days of snowfall.
- The very extreme three cold winter year ‘package’ 1939-1942; also the three winters 1915-1918 were relatively cold and form a ‘package’ that may serve as an indication for not being ‘necessarily usual’.

Sea Mines Warfare 1914 – 1918 (5_14)

How to describe sea mines in action?

This section is an annexe to the previous chapter on War at Sea 1914-18, and aims to increase public awareness to the fact that the war at sea in those days was a force big enough to alter the course of climate. Evidently, by the end of 1918 a Severe Warming occurred at Spitsbergen. The shift was so massive that the whole Northern hemisphere warmed up for two decades. The northern part of the North Atlantic must have experienced a Severe Warming at Spitsbergen. The only external force available that could have caused this event at that time was the war in the North Sea and around the British Isles.

By a number of aspects mines play an important part in ‘changing the sea’ scenario that will be discussed in the following. The number of mines laid, ships sunk by mines and mine sweeping efforts turned every metre of the seas around Britain upside down many times over a short period. Mine warfare in WWI culminated in the building of an engineering masterpiece, viz. the Northern Barrage between the Orkney Islands and the Norwegian coast, which could actually have been ‘the final straw’ to make a Severe Warming happen somewhere further north by the end of 1918. 70,000 mines had been laid since summer 1918. Whether this barrage alone or together with other military activities at sea had made the big shift is not the core question. Accounting all naval means together they had the potential to change the composition of huge sea areas from top to bottom and that should be in focus.

The war at sea from 1914 to 1918 had two phases. The first phase lasted for two years until late 1916. This phase was moderate until the second phase that followed. From late 1916 on, the full potential of sea mines, submarines and depth charges was utilised. The employment of the entire range of destructive means and the time when the Severe Warming at Spitsbergen occurred,



lie very close to each other. From all general figures mentioned in the following, presumably two-thirds and more belong to the years 1917 and 1918 and to events in the North Sea and the waters around Britain. The following text concentrates on data from this region.

Mines laid during the war

The North Sea was the main location to lay sea mines. The location and the number of mines laid depended on the anticipated target in view. Some of the main aims for all warring parties were to defend their coasts, coastal

travel, ports and naval bases. The Germans laid mines in distant waters to sink merchant and naval vessels serving Britain. The Allies often specifically targeted the German U-boats in the Strait of Dover, the Hebrides, and, most important, the Northern Barrage (see below).

Main minefields in the North Sea were the British East Coast including the Strait of Dover, Helgoland Bight and the Northern Barrage. A rough figure for each of these areas is 50,000 mines. The total number of mines in the North Sea was 190,000 and the total number during the whole of WWI was 235,000 sea mines.

Mine sweeping

Minesweeping is an activity that stirs and shakes the sea on an unprecedented scale. The ‘stir impact’ on the seas could possibly be even many times higher than the mine laying and the impact of mines that ‘hit a target’ together. Between two sweepers in motion ‘hung’ a sweep wire, with a kite, to cut the mooring rope of the mines. Britain alone had more than 700 minesweepers in permanent operation and the Germans also had a considerable number. Possibly 500 ships swept the North Sea every day, day and night. Admiral Sir R. Bacon responsible for ‘The Dover Patrol’ claimed that between 1915 and 1917 his minesweepers had swept a distance equal to twelve times around the earth¹. “Minesweepers were constantly being sent further and further afield as new minefields appeared (in 1917), and by the end of the year, over 1,000 miles of coastal waters in Great Britain and Ireland were being swept daily for mines, the work starting at dawn by different sections of sweepers stationed along the coast”.

Due to the destructive force of mines many minesweepers were lost. One example only: On April 14th, 1916, the trawler *Alberta* was blown up while sweeping a large German minefield. Undeterred its sweeping mate, the *Oracle*, went alongside the sinking vessel and she was also blown up with the loss of twelve out of fourteen men².

Manifold accounts and analyses about the loss of life at sea and damage and loss of ships exist but any questions concerning the impact on the sea have rarely been assessed. The following two reports may illustrate one aspect of sea mining that could have occurred hundreds of times.

Field Report – Example 1

From Taffrail³

While sweeping was in progress, mines usually detonated far enough astern of the sweeper to be harmful. If countermining occurred, however, a second or third mine might explode under a sweeper with disastrous results.

¹ Taffrail, p.20, p.123.

² Taffrail, p.247

³ Taffrail, p.314

A classic example of this occurred when a flotilla had been sent to skim a British deep minefield, which had been laid against submarines. The object was to skim the deep field to sweep up any mines that had been caught in shallow depth, and might be dangerous to surface ships. The minefield was large, and roughly covered the area between Rathlin Island and Skye (Northeast Ireland and West-Scotland).

Sweeping began and presently a mine went off in the sweep. Within a few seconds, the sea became chaotic with sprouting plumes of spray and smoke.



Each line of mines went off in a succession of terrific detonations until none was left. The entire minefield, deep and shallow, was thus unintentionally and automatically cleared in three minutes!

According to Taffrail⁴, Britain laid about 1,000 mines in the Rathlin

Island/Skye area, the Germans also presumably laid an equal number.

Field Report – Example 2

From Taffrail⁵

Presently a mine went off in the port wing sweep. A second later, two more exploded simultaneously – this time nearer to the ship and obviously not touched by the sweep. Countermining had started. Things were becoming exciting. Everyone looked on in apprehension, wondering where the next explosion would take place.

Thundering upheavals had now passed the ships on the port wing and were coming the line. A moment later a heavy concussion was felt in the bottom of all sweepers, and a huge dome of white water rose close at the stern of the next ship to the *Leamington*.

Operation continued

Minesweeping continued well after the armistice in November 1918 with 55 different flotillas still operating in June 1919. The British searched over 40,000 square miles until November 1919.

Drifting Mines

According to the terms of the Hague Convention mines were supposed to lose their danger from the moment they broke from their mooring. In practice

⁴ Taffrail, p.336f ⁵ Taffrail, p.315

one could not take that for granted. Actually, they often remained active and were regarded a danger to shipping and to civilians when swept ashore. Thousands of mines drifted long distances.

Losses on account of Mines

From the total number of merchant vessels sunk, ca. 6.000 vessels (12 Million tons) - only 259 ships (700,000 tons) are attributed to sea mines. The British also claimed a loss of 63 fishing crafts. Concerning minesweepers and other naval vessels sunk by mines, Taffrail⁶ gives the following account:

H.M.Ships (e.g. battle ships, destroyers, patrol boats, etc): 46,
Auxiliaries on Admiralty services: 225,
Minesweepers (sunk or seriously damaged): 214.

Northern Mine Barrage



U-boats had been a serious threat to the Allies since 1916. They regarded it paramount to prevent U-boats from leaving the North Sea into the Atlantic. To ‘close’ the northern outlet of the North Sea, about 150 sea miles (ca. 275 km), a long barrage between the Orkney Islands and Norway would be required. Off the Norwegian coast the water is 300 metres deep and the coast off Orkney about 100 metres. Sea currents can reach 3-4 nautical miles/hour. That was a challenge and required the development of a new mine, the MK6, to meet it. The charge consisted of 300 pounds of grade B trinitrotoluol (TNT). The mine itself was supposed to have a destructive radius of 100 feet (ca. 30 m) against submarines. Calculations showed that approximately 100,000 mines should effectively prevent U-boats from passing the line. Actually, only about 70.000 mines were laid until October 1918.

Mines were available by March 1918⁷, laying started. “Shortly after mine laying had commenced mines began to explode prematurely. By counting the explosions it was estimated that between 3 and 4 per cent of 3,385 mines laid blew up”⁸. In the middle section “A” mines were supposed to be



⁶Taffrail, p.335

⁷ Daniels, No.2

⁸Daniels, No.2, p.105

laid as follows: 10 rows of mines at 80 feet submergence, 4 rows of mines at 160 feet submergence, 4 rows of mines at 240 feet submergence.

Corresponding rows were laid before the Orkney Islands (section B) and Norway (section C).

From a detailed account by Daniels⁹ here are some illustrative events:

- When deep level mines exploded, 'a circle of brown discoloured water was spreading slowly around the vessel'¹⁰.
- July 6th, a mine had been found on the Norwegian coast in the vicinity of Bergen (Daniels, p.108).
- July 14th, 5,395 mines had been laid in 4 hours and 22 minutes (Daniels, p.109).
- Approximately 5% of the mines exploded prematurely – a slight increase over previous statistics.
- July 29th, 5,399 mines laid with 14% of mines going off (Daniels, p.111), at one time even 19% in section C (Daniels, p.112).
- August 18th, 12% of mines exploded prematurely.
- Section A; mines which had been laid in this area by the British in March 1918, had in the meantime been swept up. (Daniels, p.115).
- September 29th, the Norwegian Government said that mines would be laid in the vicinity of Udsire Island, and it is understood that this had been done by October 07th (Daniels, p. 119).
- With the signing of the armistice on November 11th, the building of the mine barrage ended. (Daniels, p.120).
- Final Status of Barrage (extract): up to November 11th a total of 56,760 United States and 16,300 British mines have been laid. Completion of the barrage within the Norwegian territorial waters had been effected by Norway herself.

Mine sweeping started in spring and ended in autumn 1919. From more than 73,000 mines

- about 5,000 exploded prematurely soon after laying;
- 20,000 mines were disposed of while the work was in progress;
- from the remaining ca. 50,000 mines
 - o more than 30,000 mines



⁹Daniels, No.2

¹⁰Daniels, No.4, p.47, picture caption

- o were already ‘gone’ in spring 1919, either drifted away, or exploded during winter storms;
- o rest 20,000 were swept in 1919.

Six months of sweeping operation comprised seven sweeping missions involving more than 70 vessels and 10 supply vessels.

Before closing this section, a final excerpt from Daniels’ report¹¹: In December 1918 it was regarded necessary to determine the actual condition of the mines in the barrage. Two small wooden sailing vessels *Red Rose* and *Red Fern* were chosen to cross the field. On December 22nd, “a few minutes before noon, as the vessels crossed the first line of invisible mines, a giant column of discoloured water sprang high into the air close astern of *Red Rose*. The first mine of the North Sea barrage has thus been swept”.

Mine warfare and the Norwegian Coastal Current



The Norwegian coastal current begins in the Skagerrak, about at the position 58° 45' North and 10°00' East, with water from the Oslo Fjord and Kattegat and follows the coastlines of Norway. The coastal current's speed varies between 0.5 and 1.3 nautical miles per hour (nm/h) and would have crossed the area of the Northern Barrage.

The Norwegian Current, as the extended arm of the Atlantic Gulf Current has a higher speed than its original with about 0.4 and 1.2 nm/h.

If taken a medium speed (ca. 0.8 nm/h), sea water would flow from Scotland to the North Cape in about 35 days and to Spitsbergen in about 45 days.

Summary

Together with other war at sea means the sea mines warfare played a considerable role. It has been outlined in a previous chapter the war at sea impact cooled Britain down from 1915 to 1918. With excessive snow generation during these war years, a major change could also have happened in the sea water body that generated a Severe Warming at Spitsbergen. After all, 200,000 sea mines, are more than a drop in the ocean.

¹¹ Daniels, No.4, p.12

Warming of Europe, Greening of Greenland (5_15)

Climate Change - War at Sea impact 1918 to 1939

The Theme – chain of proof

This paper aims at establishing that the war at sea from 1914-18 was responsible for the major climatic change events during the 1920s and 1930s, such as the Greening of Greenland, Warming of Europe and the Dust Bowl in the 1930s, etc. which attracted wider interest. Towards this purpose climate observations during the period in question will be analysed relating to significant changes, their timing, location, etc. If a closer link between the war at sea and any of these events can be established, it will lead to reliable evidential circumstances in support of the cause.



In a detailed analysis a close timely interrelation between the military activities and the Severe Warming at Spitsbergen has been established, (A).

The following elaboration will further establish that the major climatic events in the subsequent two

decades had their origin in the 1918 event (B). This discussion will be based on data compiled in the next section under: General Statements, Facts and Remarks, subdivided into relevant sea areas in the far north of the Atlantic.

It is widely acknowledged that the regions between Greenland and Iceland in the west, and the Barents and Kara Seas in the east, and lands surrounding them are the regions most sensitive (perhaps in the whole world) to climate changes, and that they respond very strongly to either warming or cooling¹. The Norwegian Sea, due to its size, depth, and warm current may occupy the prime place among climate sensitive areas in the polar North Atlantic (C).

Further details: (A) War at sea, 5_13, and Sea mines, 5_14; (B) Spitsbergen heats up, 5_12; (C) Sea system effected, 4_12.

¹ Lamb, Arctic Ocean, pp. 135-161.

However, each of these regions has an individual climatic history during the period from 1918 to 1939. Certain events and aspects of a sea area can provide facts to the ‘chain of proof’ that the origin of climate change was in time and location close to WWI. This shall be done by brief statements concerning the -

1. North Atlantic region relevant to the Severe warming, and for the
2. three climatic events between 1918 and 1939,

based on material compiled below under section: General Statements, Facts and Remarks, to which the reader is kindly referred to.

Impact on different sea areas

Spitsbergen had been the centre of the ‘severe warming’ in 1918, and remained the central area for the accelerated warming trend through the 1920s and 1930s.

Even though the Barents Sea played a major role in the warming-up process, it was clearly not the principal cause. It reacted more like a follow-up to what was happening further west, with clear indications that its influence increased after 1930 until 1939.

Greenland experienced a brief warming period from the early 1920s to early 1930s presumably initiated by warmer water that was diverted from the Spitsbergen Current to ‘the left’, towards Greenland in 1918/19.

Greenland Sea: Although the data available from Jan Mayen since 1922 indicate a relatively stable situation of the temperature values from 1922 to 1928, a modest rise occurred since the end of the 1920s. During the 1930s mean winter temperatures had been temporarily significantly higher. This is analysed as follows:

- a) The first period can be regarded as proof that the warming in 1918 and the following decade occurred primarily in the Eastern part of the North Atlantic, and that the brief warming of Greenland during the 1920s was a short-term ‘over-flow’ from the Spitsbergen Current or the Norwegian Sea in 1918 and during the following few years.
- b) Varying levels of warming during the second period may have a correlation with an increased influence of the Gulf Current since the end of the 1920s.

The sub polar North Atlantic had no impact on the severe warming at Spitsbergen in 1918. Available data seem to indicate that the air and sea water temperature remained on an ‘average’ until the second half of the 1920s, after which a continuous warming trend set in, lasting until 1939. Whether the modest temperature rise alone would have had any significant impact and whether it would have significantly influenced the continuous

warming of the European North Atlantic is difficult to confirm. However, by 1928 the Gulf Current seems to have flowed more forcefully towards the North; see the following paragraph.

Norwegian Sea. Very little information during the period 1918-1939 is available to assess the actual impact during the post WWI period. Nevertheless, the continuing temperature rise over the Northern European continent (e.g. Norway), and the Barents Sea and its continued stability at Spitsbergen, should be related to the warming potential of the Norwegian Sea. By the end of the 1920s the Gulf Current seems to have gained even more influence.

This assumption is based on the following facts:

- a) A stronger inflow to the Norwegian Sea in 1928 is recorded (see: section Norwegian Sea, Helland-Hansen; below).
- b) Sea areas' temperatures seem to have got some 'backing' around 1930.
- c) The warming of Europe continued forcefully through the 1930s, with the warmest winters in 1937/38 and 1938/39.
- d) The 'Dust Bowl' in the United States started in 1931 (see: below).
- e) The winter of 1928/29 had been extremely cold in Europe, which might have been caused by too warm water in the Norwegian Sea.

It seems that the Norwegian Sea presumably experienced two sea water warming events, the first in 1918, and the second about ten years later. One can only guess that the warming of air temperatures at Spitsbergen and Northern Europe during the 1930s could have been more moderate without the second event.

Remark: The winter of 1928/29 had a very special meteorological feature, so did the even more extreme winter of 1946/47. The latter is by date closely related to WWII. A time period of ten years had passed before the winter of 1928/29 occurred. After WWII it is less than two years. A correlation between WWI and WWII and the two extreme winters should not be *prima facie* ruled out. The huge and deep Norwegian Sea still holds many secrets. If one deep-sea 'bubble' had taken shape during WWI or WWII, it might take a different time period to burst.

Three major climatic events after WWI

The 'Greening of Greenland': The 'Greening of Greenland' was remarkable because it was quite sudden and significant enough for recognition. More important is the fact that the warming was on a short-term basis only. It lasted only about ten years. This is regarded as a supporting factor to the war at sea thesis. The war at sea 'initiated' a severe warming in Spitsbergen in

the waters of the North Atlantic 1918. Its impact on the water body was so massive, that a considerable part of the ‘transformed’ water at Spitsbergen took a westward direction to

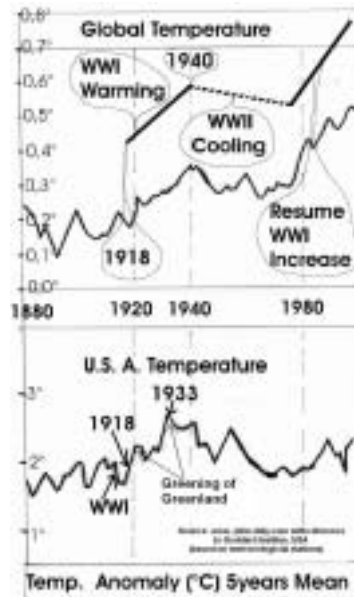
Greenland. After a short period of time a warming along the Greenland coast was observed and called the ‘Greening of Greenland’. The effect of the warm water lasted only for a short while. After one decade the warming had died away. That indicates a sudden and mighty interference, like the eruption of a volcano or an earthquake. Nature reacts, but returns to its normal equilibrium after a period of time. If the Severe Warming in 1918 was ‘war made at sea’, then the Greening of Greenland was also of anthropogenic making.

The Great Plains ‘Dust Bowl’: Recently scientists from NASA’s Goddard Space Flight Centre in Greenbelt/USA*), found by computerized climate simulations that warm water in the tropical Atlantic initiated a wind circulation that cut off the flow of moisture from subtropical waters to the Great Plains. The point stressed by the scientists is that the sea water temperatures played an important role in this matter, even if the warming or cooling occurred only for a fraction of a degree. In the early 1930s the jet stream over the Gulf of Mexico weakened and operated further south, thereby excluding the Great Plains from the common supply of precipitation.

*) NASA; -www.nasa.gov/vision; keyword: Dust Bowl; Krishna Ramanujan.

At the mid-latitude circulation the temperature gradient between the equator and the poles determines the location of the subtropical jet stream. When the polar areas are warm, as in summer usually, the gradient lessens and the strength of the westerly airflow diminishes.

A warming of the northern North Atlantic at Spitsbergen, with a serious climatic shift in 1918, and possibly, a much smaller one again in 1928, would inevitably affect the flow of the Westerly. Although the rain bringing jet stream to the Great Plains consists of low flowing air, the accelerated warming in the northern Atlantic may have played an important part in the long-term drought during the 1930s.



‘Warming of Europe’: The warming of Europe from the end of the 1910s to 1939 has been widely acknowledged since the early 1930s. The source of the warming in 1918 were the European Atlantic waters: Norwegian Sea, the Spitsbergen Current and the Barents Sea, presumably established and sustained by an internal process in the Norwegian Sea, and/or supplied by a temporarily or long-term increased inflow of Gulf Current water at the end of the 1910s and 1920s.

The warming of Europe actually started most markedly in Britain with a cooling during the WWI years from 1914-1918. The responsibility of the war at sea for this cooling and Britain’s three successive snow winters between 1915 and 1918 has been explained in a previous chapter. More important is the considerable circumstantial evidence that the Severe Warming at Spitsbergen in 1918 was presumably the immediate result of the war at sea around Britain, and in the North, Baltic and Barents Sea. Whether the total European warming period from 1918 to 1939 was solely or partly caused by WWI is of secondary importance only, if a further even more convincing cause can be named. The Severe Warming of 1918 was too serious and demands more than just a cursory interest.

General Statements, Facts and Remarks

Spitsbergen

Substantial information on the severe warming in 1918 has been compiled in chapter: Spitsbergen heats up (5_12).

Spitsbergen. (data since 1912): Spitsbergen is of special interest as the climatic warming can be particularly well observed there. The increase during winter is very pronounced².

Brooks³. At Spitsbergen the rise occurred in two stages, the winters of 1922 till 1923 had been warm, those of 1925/26 to 1929/30 somewhat cooler, and those of 1930/31 onwards warmer than the first group.

Scherhag⁴. At Spitsbergen the warming up continued until WWII, according to the following table:

Spitsbergen: Deviation of mean monthly temperatures - winter months December to March		
1918 – 19 = + 1.1	1925 – 26 = + 0.6	1932 – 33 = + 5.8
1919 – 20 = + 2.2	1926 – 27 = + 2.0	1933 – 34 = + 6.5
1920 – 21 = + 1.9	1927 – 28 = + 2.6	1934 – 35 = + 6.5
1921 – 22 = + 4.3	1928 – 29 = - 0.2	1935 – 36 = + 6.0

² Kirch, p. 22.

³ Brooks, 1938

⁴ Scherhag, Polargebiet

1922 – 23 = + 3.7	1929 – 30 = + 2.9	1936 – 37 = + 7.5
1923 – 24 = + 4.1	1930 – 31 = + 5.5	1937 – 38 = + 8.0
1924 – 25 = + 5.3	1931 – 32 = +5.6	1938 –39 = (+ 7.1)

Lamb⁵ provides a graphic account of the temperature difference between 1911-20 and 1921-30 with the centre east of Spitsbergen (+6°C). Lamb indicates that this region, together with the Norwegian Sea, seems to be the most sensitive to climatic variations.

Greenland Sea / Greenland

Jan Mayen (data since 1920): The warming is not so significant, amounting to only 0.25°C during the period 1922/31 and 1930/39⁶.

If means for the four winter months December-March are analysed, only the winters of 1928/29, 1929/30, 1932/33, and 1938/39 saw an increase in temperature of 1 to 1 ½°C. Particularly the winter seasons of 1921 to 1928 seem to have been quite 'stable', varying at the most by 0.35°C. During the 1930s a modest rise occurred. Note: The monthly mean temperature data can be found in the work of Kirch⁷.

Myggbukta/East Greenland (data since 1922; 73°29'N, 21°34'W): According to Kirch, the station's summer mean had shown a typical warming trend, lasting until 1930/39 with a maximum of 3.29°C. A cooling started in 1931/40⁸.

Analysing climate developments on the winter temperature data, one can see a warming trend since winter 1923 until 1933. Between 1933 and 1936 the previous gains (+7°C) were lost. Winter temperatures got +5°C warmer again since 1936 until winter 1938/39. Note: The monthly mean temperature data can be found in the work of Kirch⁹.

Manley¹⁰: The last 'bad ice year' in the Greenland Sea was 1923.

Bjerknes¹¹: The sea surface temperatures near Greenland culminated in the early 1930s.

Carruthers¹² mentions that due to warmer water, the cod fishing by Greenlanders, increased dramatically, from 500 to 1,000 tons in 1922-1925, to 8,000 in 1925-1929 p.a., whereas the catch decreased to 6,000 tons in the year 1937. An excessively low temperature off East Greenland's coast affects the survival of cod is confirmed by Nellen¹³, showing in a graph that the

⁵ Lamb, Arctic

⁸ Kirch

¹¹ Bjerknes, Atlantic

⁶ Kirch

⁹ Kirch

¹² Carruthers

⁷ Kirch

¹⁰ Manley

¹³ Nellen

production continued on the level of about 5-6,000 tons until 1948, then accelerated ten-fold, but dropped almost to zero in the late 1980s.

Bjerknes¹⁴ analyses the warming in the 1920s as follows:

North of about 57° North the trend in sea temperature has been slightly upwards. Actually this change resulted from a brief but strong upward trend in the 1920s, which overcompensated the accumulated effect of a preceding long and slow downward trend. A somewhat similar brisk upward trend, starting as late as 1920, is found in the Labrador Current.The warming of the waters in the far northern Atlantic (to which the Pacific has no parallel) was much more sudden and short in range than farther south. Essentially, it lasted only from 1920 to 1930 in Greenland waters and from 1920 to the early 1940s in Iceland and northern British waters.

Barents Sea

Boar Island (data since 1920): The recorded winters of 1920 and 1921 (January/February) were significantly colder than the following, except 1928/29, until the winters of 1939/40 and 1940/41. In so far the warming started with the winter of 1921/22. The annual means are fairly equal (1 to 3.2°C, between 1920 and 1932), only getting warmer after 1932.

The winter means show a general rising trend until 1939 since data are available. What is noticeable is a considerable 'unrest' on a short-term basis, e.g. the December/February means in the winter of 1921/22 were -10°C, one year later it was - 3°C. The cold winter of 1928/29 in Europe is fully reflected in the data record and quite obviously not related to the sea water conditions in the Norwegian/Barents Seas. Note: The monthly mean temperature data can be found in the work of Kirch¹⁵.

Vardo/Norway (North Cape) (data since 1867): After a pronounced cooling during 1909/1918, a strong increase with 0.8°C by 1913/22 occurred, which remained constant until 1919/28. This was followed by a cooling by 0.5°C until 1923/32, culminating in a rapid warming in 1930/39¹⁶.

Taking the winter temperatures as the main indicator of the start of a warming trend, at Vardo the warming only started in winter 1919/20 (December-March), being one degree warmer than the previous years, but also showing a clear warming trend in annual means. Note: The monthly mean temperature data can be found in the work of Kirch¹⁷.

Kelly, et al¹⁸: The 1920s was a decade with strong warming in the Arctic regions. The Barents Sea and Kara Sea had warmed annually by 2°C by the

¹⁴ Bjerknes, Atlantic

¹⁵ Kirch

¹⁶ Kirch

¹⁷ Kirch

¹⁸ Kelly

mid-1920s, and the Greenland sector had warmed by a similar amount by the end of the 1920s. The warming continued during the 1930s, but more pronounced in winter.

Schokalsky¹⁹ reported of a dramatic thinning of the upper layer (up to 100 m), that was less salty and colder than the lower 600-800 m layer of Atlantic water (high salinity and about two degrees warmer) between Franz Josef Land and Novaya Zemlya, as observed in 1928 and later on, with warming tendency.

Blacker²⁰ indicates that south of Spitsbergen the warm West Spitsbergen Current had been kept at bay by two cold currents, the Bear Island Current and the East Spitsbergen Current before 1930, and that the West Spitsbergen Current had had no influence beyond 75°N. Blacker continues: The West Spitsbergen Current greatly increased in volume so that it now covers most of the bank as far north as Isfjord, and has a marked influence even further north. A similar chain of events must have caused the disappearance of most Arctic species from the Bear Island region. Blacker concludes (p.37): Changes in the distribution of benthos in the area since about 1930 indicate that there has been a great increase in the area of the bottom over which Atlantic conditions are predominant, and a corresponding decline in the area influenced by Arctic conditions.

Hesselberg, et.al²¹: The rise in the temperatures at Isfjord is confirmed by the data from Vardo (North Cape). Also here the increase is especially rapid about the year 1920, but the rise is more modest.

Blacker²² reports: Russian scientists have recorded changes in the bottom fauna of the Murman coast and Kola Fjord with an increase of boreal species. When compared with the years 1900-06, these changes have been related with an increase of about 1°C in the mean bottom temperature of the Murman Current for the period 1921-26.

Norwegian Sea

Helland-Hansen²³ reports observations in a section crossing the Norwegian Atlantic Current, where a very marked change occurred in 1928, when temperatures and salinity had relatively higher values than previously observed. From May 1927 to May 1929 the dynamic calculation showed an increase in the masses of the 'Gulf Current' streaming northwards to the

¹⁹ Schokalsky

²⁰ Blacker, pp. 1, 35, 37

²¹ Hesselberg, et.al, Polar, Fig.2

²² Blacker

²³ Helland-Hansen

Norwegian Sea of about 20%. The effect was observed in high latitudes after a couple of years.



Kushnir²⁴: From 1920 onward a basin wide warming ensued, leading to warm anomalies after 1930 or so, depending on latitude and whether sea surface temperatures are examined. The increase is highest in the section 60-70°N (according to Fig.2, p.144).

Manley²⁵: A rise in winter temperature means in Norway started after winter 1918/19 with 1-2°C during the next two decades.



Atlantic – South of Iceland – West of England

Bjerknes²⁶: Maximum sea surface temperatures occurred from Iceland to England in the early 1940s.

Bjerknes²⁷: While investigating the sea surface temperature (SST) conditions between Iceland and the Azores (time series of annual sea temperatures from 1850-1960), he states: ‘the sea temperature at the centre goes through the

maximum a little after 1890, the minimum a little after 1920, and again the maximum after 1940 (for 61.5°N). Actually, the ‘time series’ mentioned by Bjerknes (ditto, Fig.5) indicates a modest rise in the SST since about 1926 until the second half of the 1930s.



Deser et.al.²⁸:

A dominant mode of variation in the winter time surface climate over the North Atlantic during this century is associated with the global surface warming trend during the 1920s and 1930s. It tempts to speculate that the observed climate trends over the North Atlantic during the 1920s and 1930s were due to an intensification of the thermohaline circulation (ditto, p.1752).

The pattern of change in sea surface

²⁴ Kushnir, Yochanan
²⁷ Bjerknes, Fluctuation

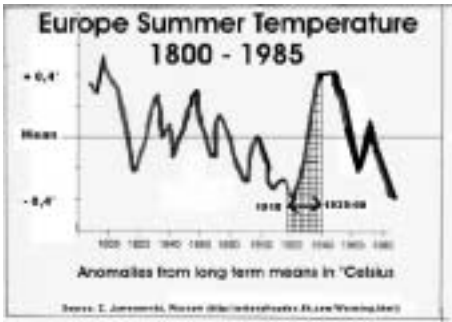
²⁵ Manley, Fig.4
²⁸ Deser

²⁶ Bjerknes, Atlantic

temperatures and air temperature between 1900-29 and 1939-68 (or equivalent, the trend during 1917-39) indicate that the warming was concentrated along the Gulf Stream east of Cape Hatteras. The warming also occurred over the Greenland Sea and the eastern subtropical Atlantic.

Eythorsson²⁹: Iceland air and sea temperatures had been rising for over two decades since the 1920s, the rise was most pronounced during the winter months (Fig.1 and 5).

Rodewald³⁰ published in 1948 the deviation of water temperatures at South Iceland from 1895-1939. These figures provide the strong indication that the warming of the ocean at Iceland started only in 1926, which can be regarded as proof that the warm sea water that initiated the warming at Spitsbergen needed about six years to reach Iceland. Due to the significance of these data the record from 1895 to 1939 is reproduced as follows:



Slevogsbank (South Iceland) 63°N, 21°W, sea water temperature differences 1895 –1939

1895, +0.84	1906, -0.27	1917, -0.16	1926, +0.22	1935, +0.47
1896, +0.24	1907, -0.56	1918, -0.05	1927, +0.14	1936, +0.54
1897, +0.19	1908, +0.21	1919, -0.42	1928, +0.93	1937, +0.47
1898, -0.16	1909, +0.37	1920, -0.39	1929, +0.43	1938, +0.73
1899, -0.03	1910, +0.35	1921, -1.07	1930, +0.12	1939, +1.10
1900, -0.02	1911, -0.19	1922, -0.65	1931, +0.14	
1901, +0.28	1912, +0.08	1923, -0.62	1932, +0.39	
1902, +0.20	1913, -0.28	1924, -0.08	1933, +0.66	
1903, -0.10	1914, -0.63	1925, -0.14	1934, +0.54	
1904, +0.43	1915, -0.45			
1905, -0.23	1916, -0.05			

During the time before and after 1926 there was roughly a jump in sea water temperatures of more than one-half degree. This was a very significant change that might have been getting some support from the warming of the north of the North Atlantic, commencing at Spitsbergen in 1918, that reached Greenland in the early 1920s and arrived in Iceland in 1926. However, the Gulf Current would in principle, have caused a warming of the Irminger Current.

²⁹ Eythorsson ³⁰ Rodewald, Bemerkungen ³¹ Rodewald, Golfstrom
Extract from „Climate Change & Naval War – A Scientific Assessment 2005
Trafford on demand publishing, Canada/UK © Arnd Bernaerts

Rodewald³¹ provides sea water temperatures, all showing an increasing tendency since 1919 in respect of three sea areas in the East Atlantic, as follows:

Sea Area	Ca. Position	1906 - 1913	1919 -1939	Shift in °C
Irminger Current	63N,10-20W		Strong increase	+ 2.5 °C
West of Scotland	57N, 15W	Strong varying	increase	+ 1.0 °C
SW of Ireland	50N, 19W	Strong varying	increase	+ 1.0°C

Lumby³²: In the south-west of Ireland (ca. 100 km), it is evident that until about 1927 temperature conditions at 200 m remained more or less static, but after that an increase took place, which, so far as may be judged from the somewhat scanty observations, has in recent years reached an amount of $\frac{3}{4}$ °C.

Brown³³: The mean annual air temperature for the area around 51°N 12°W (ca. 200 km west of south-west Ireland) during the period 1880-1960, shows little average trend over the whole period, although it does show a marked warming trend from 1922-1939. The mean annual sea temperatures also show this rising tendency from 1922 to 1939, and also there was a small average rising tendency for the sea temperature over the whole period.

³² Lumby

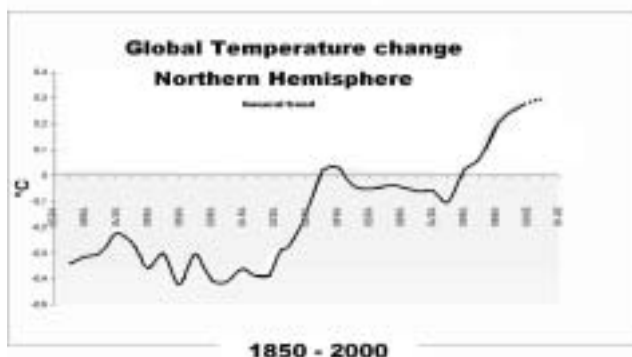
³³ Brown

F. Climate changes twice

Two wars at sea – Two climate shifts (6_11)

The basic assumption

This study is based on the assumption that the driving force behind climate is the ocean, explained as follows: The oceans generate a master plan for the atmosphere, like a blueprint¹. The atmosphere will implement the plan within a short period of time. Subsequent ‘atmospheric conditions’ lead to the climate, being nothing more than “the continuation of the oceans by other means”, viz. ‘gaseous water’, named water vapour or humidity.



On the assumption that the climate is ocean driven, this study assumes that significant climatic changes during the last century have had their origin in the two World Wars, viz.

1914-18 and 1939-45. During the wars military forces were so intensive and so mighty that they changed regional seas or ocean areas to such an extent that the oceans altered the blueprint, which subsequently changed the climate data series.

While any significant climate change is quickly reflected in the weather data observed, particularly in temperature records, the detection of the source of climatic changes is somewhat more difficult, simply because there is no comparable data available on ocean observation as for the atmosphere, i.e., when, how, and why the oceans' blueprint changed has rarely been observed and recorded comprehensively. Hence the responsibility of the war at sea for most significant climatic changes during the last 150 years cannot be proved by ocean data alone, but must primarily be drawn from meteorological data.

¹ Preface, page 5-6; see previous chapters: Cyclones and shells, 2_21; Oceans at war 1942-1945, 4_11; Bernaerts, Climate 1992; Bernaerts, Nature Extract from „Climate Change & Naval War – A Scientific Assessment 2005 Trafford on demand publishing, Canada/UK © Arnd Bernaerts

The relevance of the war at sea concerning a number of significant weather conditions and climatic changes observed in the last 100 years is subject to a number of explanations. These workouts are the basis for the following considerations without necessarily referring to all of them individually.

Overview of climatic changes since 1880

End of the Little Ice Age – 1880

The second phase of the Little Ice Age lasted from about the late eighteenth to mid-nineteenth century. While the exact decade in which this period ended is debatable, it is undisputed that global temperatures started to rise about 1880 at the latest. This fact was observed and widely acknowledged well before WWII. This trend is often explained as a recovery from the cold days of the Little Ice Age. The rise was more pronounced in the Northern Hemisphere. The Intergovernmental Panel on Climate Change, and others, have presented figures and data that indicate the rise.

The temperature rise between 1880 and 2000 is interrupted only twice. If one chooses to ignore these two interruptions, there is a constant increase in temperatures at an almost equal pace during the last 150 years, particularly since 1918. One of the main reasons for this lasting trend is presumably the fact that the earth has been spared a major volcano eruption since Krakatoa in 1883.

Warming of Europe – 1918 to 1939

The general warming trend met with its first major change in 1918. Suddenly the moderate increase received a major push. The rise accelerated in the North, particularly in Europe, for two decades. This change was due to a sudden and Severe Warming at Spitsbergen in the second half of 1918. This change can be dated very precisely to a time frame of six months. This very short period of time is closely related to the most destructive phase of naval warfare in the North Sea and around Britain from the end of 1916 to 1918.

Further details: War at sea 1914-18, 5_13; and Spitsbergen heats up, 5_12.

Four decades of cooling – 1940 and after

The ‘accelerated’ warming trend observed since 1918 ended in the middle of December 1939. The war at sea in the North Sea had blocked the Westerlies from passing through Western Europe. The region where the halt came can be located as the coastal corridor from the Helgoland Bight in the North Sea and in the Baltic Sea from Kiel to Königsberg (Kaliningrad). Only 100 days earlier Hitler had started the Second World War, and the coastal waters

mentioned were particularly affected by naval activities and had succumbed to arctic winter conditions.

Further details: Lost West Drift, 2_12; Sea mines 1939, 2_14; and North Sea cooling 2_16.

Although two very big events with a strong impact on weather occurred in December 1939, they did not change the ‘general climatic course’ generated and sustained in the North- and Baltic Sea. One event took place high in the North under the Arctic Circle; the other event was a major earthquake in Turkey on December 27th, 1939.

Further details: Russian-Finnish war 1939, 2_41; Turkey earthquake, 2_51.

A ‘land based’ military aspect also could have played a side role on influencing the weather in late 1939. While it rained excessively around the region where the French and German Army met at the Western Front, the United States was deprived of rain in November 1939. This constellation may have contributed to China’s and the USA’s cold January 1940.

Further details: Rain-Making, 2_31; USA dried out, 2_32; and War in China, 2_33.

The end of a continuous rise in temperature in December 1939 was definitely a full halt to the rising trend for four decades. The temporarily ‘halt’ of temperatures occurred during certain time periods or in some regions where even a clear cooling down was witnessed. Viewing the general trend in the Northern Hemisphere not too narrowly, the period from 1939 to the late 1970s could be described as modest cooling

Global Warming – 1980 and after

Somewhere between 1975 and 1980 the ‘modest cooling’ trend disappeared and the warming trend restarted which had been halted in 1939. From 1980 on, the pace of the increase was as high as during the period between 1918 and 1939, or even higher.

Concerning the pace of the temperature increase since 1980, the chapter: ‘Sea system affected’ (A), raised the issue whether the forcing down of warm surface water to lower levels during WWII could be a contributory cause to the warming of the atmosphere ever since. This cannot be excluded. Heat, which is stored in the ocean, needs a long time to get out in due course. As long as the war lasted the ‘forcing in’ saw at least some ‘forcing out’ as well. But once the fighting ceased, any ‘excessive heat’ may need years or decades for getting to the ‘platform’ for evaporation.

Further details: (A) Sea system affected, 4_12.

Special feature of the war periods 1939/42 and 1942/45

Special features of the three war winters 1939-42

The overriding aspect of these three winters is that their severity in climatic and military terms is related to Northern Europe and that they lasted for three successive years.

The severity in climatic and military terms related to Northern Europe means that the main and the most severe naval activities and the great deviation from average weather conditions coincided by time and region perfectly. Massive naval activities match the arctic winter conditions.

This ‘perfect match’ was achieved in Northern Europe. It were not the North Atlantic, the Barents Sea or the Mediterranean Sea, but the North and Baltic Sea. Both of them lost too much of their summer heat too early due to naval activities. An ‘axis of cold’ from Stockholm to London was established because continental conditions prevailed.

Further details: Cold axis, 3_22; Baltic Sea Cooling 1939/40, 2_17

A very significant feature of the three war winters is their appearance during three successive winters. This is unusual. It had never before occurred since weather observations had first started being recorded.

Further details: Three-years-winter-package, 3_31.

In summary it can be said that the first three war winters were ‘made and felt’ in North Europe. The relevant climatic sources were the North and Baltic Sea. The war at sea was the ultimate cause.

The three war winters changed the climate, at least the annual mean temperatures decreased.

Speciality of the war period 1942/45

When the United States entered WWII after the attack on Pearl Harbour in December 1941, the war at sea left its principal confinement to European waters and became global. Going global did not mean that the fighting became less intense and severe around the European continent but that the fighting was stretched over whole oceans, with more men, more ships and more equipment.

Going global means in particular that the impact of the war at sea on the weather (in the widest sense) no longer primarily originated in Europe (North and Baltic Sea) but also from the ocean space of the North Pacific and Atlantic. While the global war at sea continued, its impact dominated over the impact felt in European waters.

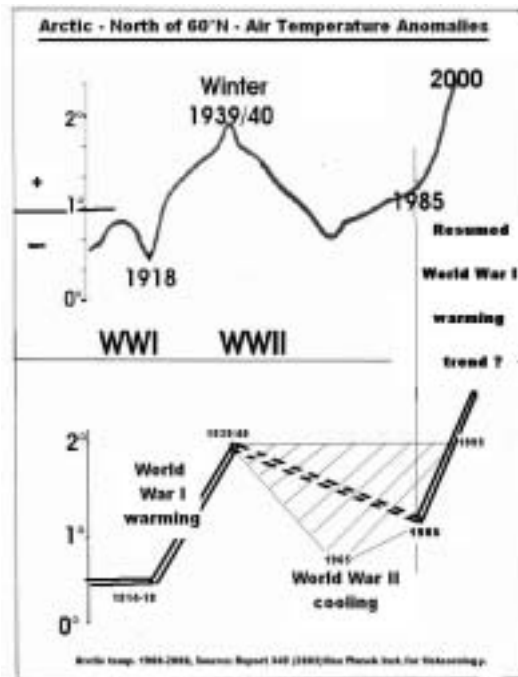
The North European war winters of 1942/43, 1943/44 and 1944/45 being regarded as 'normal' presumably has a lot to do with the fact that tremendous naval activities along the width of the oceans increased the evaporation, thereby strengthening cyclonic activities that brought maritime air to Europe.

Further details: Oceans at war – WWII in the North Atlantic and Pacific, 4_11.

Climatic relevance of major temperature periods

1900 to 1918: A generally moderate warming trend that started around 1880 and lasted until 1918.

1919 to 1939: At the end of WWI a severe warming occurred at Spitsbergen. The pre-1918 trend increased. A massive naval warfare had taken place in close proximity. Water from battlefields from around Britain travelled northwards and reached the seas at Spitsbergen after a few months time. The severe warming influenced the climate of the Northern North Atlantic and initiated a warming process in Europe, which lasted two decades.



The Severe Warming at Spitsbergen was the first of two outstanding climate changes during the last century.

Goethe, known for his interest in the young discipline of modern science, never lived by the sea. The Mediterranean was the only sea he ever saw. While 20,000 people from all over the world flew across the oceans to the Earth Summit in Rio, Goethe only crossed the sea from Neales to Palermo in 1787. A bit seasick, he stayed in bed enjoying the unfamiliar environment as he felt relaxed and wrote in his diary "Italian Voyage":

Until one has experienced the sea around one, one has no idea of world and its relation to the world.

He himself was delighted by this 'simple but great' line and mentions that it changed his thinking. The foundations for the dramatic figure Thales in Faust II, finished 40 years later, were laid. At the same time, global average temperatures fell dramatically, something which Goethe called the Cold Epoche. While this expression is still used in science, the Epoch after Goethe lost touch with basic principles. They strived to understand the natural commons by means of mathematical and statistical tools, most visible in the field of weather and climate (Warming Up, LOS 5/93, P.6)*.

The rule of the oceans was forgotten and buried for two centuries. Now the 1982 Law of the Sea provides a chance to rediscover the lost common understanding of how nature works. In addition, Prontus still offers politicians and other interested people the sea for personal experience, either now, or while traveling by sea to the next Earth Summit. A lesson which he was able to teach Goethe and the Greeks, should still be possible today. Even though only few will probably have taken the opportunity to relearn the basics by 16th November 1994, welcome the 1982 Law of the Sea anyhow.

A nip from the ocean, a glass of water will be just fine. Cheers!

¹ Arnd Bernaerts, "BACK TO WATER - CHEERS", L.O.S. Lieder#33 Vol. 6, No. 1, April. 1994, Professional correspondence from the Law of the Sea Institute, William S. Richardson School of Law, University of Hawaii.

*) see: Preface in section Introduction

1940 to 1942: Northern Europe experienced three winters with Little Ice Age characteristics. The winters were ‘war-made’ (see above). They were climatically relevant in so far as they are significant milestones in the statistics. They are significant climatic events due to their lengths (each about four winter months) and severity. However, as their appearance and impact was largely confined to Northern Europe, one could also categorise these three winters as major weather-modifying events.

Whether these three war winters would have had a long-lasting impact if the war had ended before Pearl Harbour is impossible to assume, not even in the most general terms.

The war winter of 1939/40 marks the second outstanding climate change during the last century, which lasted for four decades until the end of the 1970s and includes the following period from 1942-1945.

1942 to 1945: This period is not particularly ‘visible’ in global temperature records, although a differentiation of data such as ‘before and after’ Pearl Harbour should be made. The global war at sea after Pearl Harbour presumably had a number of short-term and long-term impacts.

As an example of the short-term impact it is possible to cite the forcing of cold water to the sea surface, forming or influencing water turbulences, or increasing evaporation. A main long-term impact is the forcing of warm surface water into deeper layers where it remained over a longer period of time.

The impact of the global war at sea falls definitely in the category of climatic change, including the second major change in the 20th century in winter of 1939/40.

1945 to 1979: Whether the period saw a small drop in global temperatures or only the halt of the pre-WWII increase is of little interest here. What matters is that the cause for the halt for several decades is still unexplained. The war at sea from 1939-1945 is a highly probable cause for this halt.

1980 – present: As nothing more happened in the late 1970s than the “disappearance” of the 1939/40 halt to ‘the rising trend’, one could ask whether the warming trend after 1980 was actually a climatic change event, or only a resumption of the pre-1940 warming trend. Although this event does not have any practical impact, as a reliable explanation it would help to understand better the four-decade halt to the warming trend.

Whether there still remains the lasting impact of WWII is not only a theoretical probability. As the oceans are capable of storing heat for an unlimited period of time and retain it over long time periods, it is quite possible that some of the heat forced into lower ocean water levels during WWII half a century ago, has resurfaced since the 1980s.

What conclusion can be drawn?

Human impact by the two wars at sea 1914/18 and 1939/45 on regional and global climate has been explained in a number of chapters. The anthropogenic climatic forcing occurs primarily through changes and modifications to the 'natural' status of ocean and seas. They transform this to short-term weather modification, or long-term climatic changes.

If the thesis on climatic changes by war at sea activities has its merits, some explanations on the general warming trend since 1880 may have to be reviewed. Like the anthropogenic impact over two short periods within just a few years, which accelerated the warming trend in 1918, and halted it in 1939, the industrialized world uses global oceans and seas excessively, by installations in tidal waters or floating means, particularly by naval, merchant and fishing vessels. Hardly any of the numerous uses is neutral in the way that the temperature and salinity structure is not 'affected'. While there is 'input' and 'output', the overall balance sheet will show higher figures on the 'input' side, due to the high insulating capacity of water. However, on the 'output' side it eventually results in warming the atmosphere.

With the end of the Little Ice Age, the use of the oceans no longer remained 'neutral'. Day by day huge water masses are 'turned about'. What it means in climatic terms could be demonstrated by explaining the climatic impact of the war at sea. Understanding the global warming trend since 1880 primarily means understanding the structure, conditions and changes of the oceans and seas.

Epilogue

Article from 1994

Following article by the book author was published 1994 in 'L.O.S. Lieder' of the Law of the Sea Institute, William S. Richardson School of Law; University of Hawaii¹.

BACK TO WATER - CHEERS

The most fascinating thing about the day on which the 1982 Law of the Sea Convention comes into force in a few months' time will presumably be the fact that hardly anyone will be fascinated. While the Earth Summit forced 170 countries to fly their leaders and delegates to Rio in order to plan the planet's preservation, not even two heads of state will meet on 16th November 1994 to pay tribute to the 1982 Convention, although this paper will pave the way for rediscovering that water matters and that its source is the oceans.

The 1982 Law of the Sea is to further understanding on the natural commons buried since the industrial revolution 200 years ago. To the ancient Greeks, Mother Earth was Gaia. Once she and her fellow planets had found their place in orbit they lived as fire spitting rocks. Only Gaia had a son, who is still alive, Prontus, the oceans. Thales of Miletus (640-546 B.C.), the earliest philosopher and considered to be one of the Seven Wise Men of Greece, called water the fundamental element of all things. As this thesis was only preserved for several hundred years by oral tradition before being written down by Aristotle, Thales' thoughts fit well into the picture of Gaia and Prontus. A mother born in the depths of the universe, aged, wrinkled but still alive, as shown by volcanic activities, and a son in his best years, strong, dominant and the source of life on earth.

More than 2000 years later the poet Johann-Wolfgang v. Goethe (1749-1832) gave Thales a voice in his drama, Faust II:

*Everything comes from water!!
Everything is maintained through water!
Ocean, give us your eternal power.*